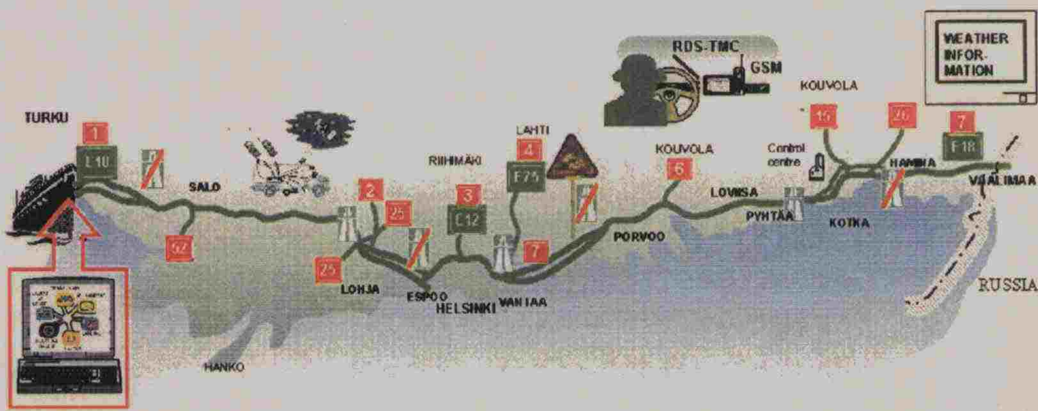
Finnra

Jukka Lähesmaa, Anna Schirokoff and Yrjö Pilli-Sihvola

Transport Telematics – E18 Test Area



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ABSTRACT

Transport telematics solutions for traffic management, information services and winter maintenance were tested and evaluated on the E18 road. The aim of this E18 programme was to develop data collection and processing as well as information dissemination systems and methods, and to integrate the individual systems. The aim was to find out what kind of system would be most suitable for Finnish needs.

The E18 programme included about 50 transport telematics projects, which were divided into four categories. The categories were data collection, data processing, information dissemination and evaluation of the systems and their impacts.

The executive group of the programme followed the projects and decided on the funding. The programme team controlled that the programme meets its goals. The total funding of the programme was about 29 million Finnish marks. About 13 million FIM was used for R&D projects and 16 million FIM for investments. The central administration funded the R&D projects and road districts mainly the investments.

The aims, main findings and recommendations of each project are introduced in the report. A summary is also given that includes the most important results and recommendations to the four project categories.

A Finnish road transport telematics solution was developed based on the findings in the E18 programme. The solution describes the goal for using telematics, telematics means to meet the goals and different means to monitor traffic and road weather. The solutions were developed for different road environments: inter urban motorways, main highways in urban areas, two lane roads with high traffic volume, two lane roads with low traffic volume and individual places. The means for processing data are the same in each environment. The facts that Finland is low-density populated and weather has often significant effect to the traffic gave special characteristics to the telematics solution.

It was beneficial to gather the projects into a programme. The experiments were centralized to one highway and it was easy to get and deliver information on the projects. The co-operation of road districts and central administration was very important. The programme promoted the utilization of consistent solutions.

The external parties were quite well informed on the programme. There were papers on the programme and projects both in domestic and international seminars. It would, however, have been beneficial to give even more time and resources to the communication.

The E18 project team described the most important transport telematics R&D tasks for the future based on the enquiry send to the road districts and central administration. Both road districts and central administration have the skills and knowledge needed in the R&D work and contribution from both of them is needed. The development has to be controlled. As the VIKING programme is in the future more focused on the implementation projects a new way of gathering and delivering information on R&D projects is needed. Also a new steering group might be needed to control the R&D work and to agree on the starting of new projects as well as to follow the results.

The project has been granted European Community financial support in the field of Trans-European Networks - Transport.

PREFACE

Traffic safety and efficiency can be improved through transport telematics. This combination of telecommunications and automatic data processing has been utilized only relatively recently in transport. The Finnish National Road Administration's (Finnra) project ”Transport telematics – E18 test area”, a continuation of the Finnra project ”Traffic management”, was carried out for a period of three years (1996-1998) and operated as a test area for several telematics solutions in traffic management and winter maintenance.

The trial studied the impacts and usefulness of transport telematics and how transport telematics could be utilized on a national scale. The E18 programme consisted of approximately 50 projects, including European research projects concerning telematics, such as the TROPIC project, which studied the applicability of Variable Message Signs, the PROMISE project, which concerned the transferring of information to drivers via GSM mobile phones and the Internet, and the FORCE–ECORTIS project, which promoted the utilization of RDS-TMC traffic information services. Some of the projects were part of the Euro-regional Viking programme on road traffic management.

The Finnra Central Administration and Road Regions co-operated on the test area. The participating Road Regions were the Turku, Uusimaa and Kaakkois-Suomi Road Regions, which the E18 road passes through, as well as the Oulu Road Region. Several members of Finnra personnel as well as consultants, researchers and operators participated in the planning, implementation, utilization and impact evaluation of the projects. I would like to thank all of them for participating in this programme, thus making the realization of the test area possible.

This final report is a summary of the results of all of the projects that were parts of the programme during the three years between 1996 and 1998. The summaries and conclusions were drawn up by the program team. The final report has been compiled by Jukka Lähesmaa and Anna Schirokoff. I would especially like to thank them and the entire programme team for their brilliant co-operative effort.

TEN-T (Trans-European Networks – Transport) funding, allocated for the development of the European Union's basic transport infrastructure, was received for drawing up the report.

Kouvola, 9 December 1999

Yrjö Pilli-Sihvola
Project coordinator of the Transport telematics – E18 test area -project
Kaakkois-Suomi Region
Traffic Services

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1 INTRODUCTION

The main problems concerning passenger and freight transport in Finland are:
- Finland is a relatively large and sparsely populated country.
- Finland has over 1000 kilometers of main roads classified as having several problems and especially the maintenance of the lower category road network is demanding.
- The weather and road surface conditions reduce traffic efficiency and safety.
- The main arterials and certain main road sections in large urban areas are congested at certain times of the day.

Very often, the simplest and most inexpensive solutions have already been used, and it is difficult to receive funding for large-scale road construction. Problem solving calls for the full-scale utilization of available solutions. Transport telematics is one such possible solution.

Telematics is a form of information technology, which includes telecommunications, and data processing technology. Transport telematics is a general term used to describe technology used to collect and process data on road conditions, traffic and mobility and utilize this data in traffic Control, information services or the management of a fleet or individual vehicles. Transport telematics is a tool used in traffic management. It is used in order to affect the choice of route and the timing of the trip, the choice of transport mode, transport demand and driver behavior in a way that promotes the efficiency, safety, economic viability, environmental safety and comfort of traffic. (Finnra1995b.)

As the Transport telematics – E18 test area –programme began in 1996, transport telematics were mostly utilized as independent services. Several projects were either already implemented or being planned. Between 1993 and 1996, Finnra examined the utilization of transport telematics in the Traffic management -programme, resulting especially in the development of information services. One of the most important services was traffic information on the radio, for which Finnra provided information on the local weather and road surface conditions, road works and predictions concerning the traffic on major holidays. Finnra's own information service provided information on the weather and road surface condition via teletext, phone and the Tie-info –monitors and information kiosks at service areas and service stations.

The Road Regions had implemented several Variable Message Sign systems. These included e.g. slippery road Variable Message Signs on highways 1 and 8, road surface condition- and weather-controlled speed limits on the weather-controlled road between Kotka and Hamina, the lane control system at the Kallansillat -bridges and the queue warning system on the Länsiväylä -road.

The aim of the E18 test area –programme was to develop an effective and practicable system by combining individual data collection, processing and utilization systems. The E18 was chosen as the test area, because it is an important road for both domestic and international traffic. The road consists of various sections, which could be examined separately. Many of the existing projects were also located on the E18. The test area was used to study the impacts and usefulness of transport telematics, and the results obtained thus were then used for determining a Finnish transport telematics solution. The telematics solution is a current estimate of the various transport telematics methods that can be used on different road sections, and the ways in which data are collected and processed.

2 OBJECTIVES AND IMPLEMENTATION OF PROGRAMME

2.1 Introduction

Various telematics solutions concerning traffic control, information services and road network winter maintenance were tested and evaluated on the E18 road, the test area for the Transport telematics -programme. The aim was to develop an effective and practicable whole from individual data collection, processing and utilization systems - to find the best system for Finnish conditions and to formulate principles for the uniform utilization of telematics solutions in all of Finland, especially on the roads that belong to the Trans-European Road Network (TERN). The project aimed for the uniform and controlled development of the implementation and utilization of telematics in public road maintenance and information services for road users. (Finnra 1996.)

The project began with the common desire of Road Regions and Central Administration to test and develop transport telematics in a controlled environment. The E18 –programme did not have any direct impact on the realization of individual projects. The programme wanted to combine approximately 50 transport telematics projects in order to make them easier to monitor and to enable the general and joint use of their results.

The E18-TERN road –development programme has also been going on at Finnra during the Transport telematics – E18 test area -programme. The TERN road E18 from Turku to the Russian border is Finnra's greatest target for development. Road improvement and construction measures are used on the E18 to reduce the current congestion level and to improve the traffic connections of this internationally important road.

2.2 Programme areas

The programme areas were

- the development of data collection
- the development of information management
- the development of the distribution of data
- system and impact assessment.

The data collection –area concerned the improvement of the quality of basic data by utilizing existing collection systems, developing new systems, and by increasing the analysis of the collected data. The information management –area defined the Road Traffic Information Center information database, which unites the individual, separate information systems, and started the phase-by-phase designing and implementation of this database. In the distribution of data -area new traffic control and information services were developed and implemented. The impacts of the implemented systems on traffic and road maintenance were assessed, and the technical applicability and cost efficiency of the systems were also evaluated in the fourth programme.

2.3 Organisation

2.3.1 Steering group

The programme had a steering group assigned to monitor the development of the programme, to decide on funding, to handle deviations from the project design and to decide on follow-up actions on proposal of the programme coordinator. Between 1996 and 1998, the steering group consisted of the following persons:

- Lassi Hilska, 1996-1998, Ministry of Transport and Communications
- Kari Hiltunen, 1998, Traffic and Road Research (Road Data)
- Jorma Hintikka, 1996-1997, Uusimaa Region
- Eini Hirvenoja, 1997, Traffic Services
- Reijo Hörkkö, 1996-1998, Turku Region
- Jukka Isotalo, 1996-1998, Directors
- Kari Karessuo, 1996-1997, Strategic Planning; 1998, Uusimaa Region
- Pentti Karvonen, 1998, Traffic Services
- Risto Kulmala, 2/1996 - 7/1997, Strategic Planning; 8/1997-1998, Technical Research Center of Finland (VTT)
- Eeva Linkama, 1998, Strategic Planning
- Aulis Nironen, 1998 chairman, Directors
- Mirja Noukka, 1996-1998, Traffic Services
- Yrjö Pilli-Sihvola, 1996-1998, Kaakkois-Suomi Region
- Olli-Pekka Poutanen, 1996-1997, City of Helsinki
- Matti-Pekka Rasilainen, 1996-1997 chairman, Directors; 1998, Uusimaa Region
- Matti Roine, 1996-1997, Technical Research Center of Finland (VTT)
- Kari Sane, 1998, City of Helsinki
- Markku Tervo, 1997-1998, Oulu Region
- Pauli Velhonoja, 1996-1997, Traffic and Road Engineering
- Lea Virtanen (former Asplund), 1998, Traffic Services

2.3.2 Programme group

The programme group managed and monitored that the programme advanced according to plan by coordinating the functioning of the working groups operating on the four programme areas. The programme group agreed on future tasks and decided on alterations. The programme group consisted of

- Regional representatives

- Leo Koivula, Uusimaa Region, representative of the E18-TERN road –development programme, 1996
- Ilpo Muurinen, Uusimaa Region, representative of the Matheus-project
- Pekka Rajala, Uusimaa Region
- Mika Vahala, Turku Region, up until 3/98
- Juha Ylikorpi, Turku Region, from 3/98 onwards
- Pekka Leviäkangas, Kaakkois-Suomi Region, up until 3/98
- Petteri Portaankorva, Kaakkois-Suomi Region, from 6/98 onwards

- Jukka Savolainen, Kaakkois-Suomi Region
- Kimmo Toivonen, Kaakkois-Suomi Region

– Representatives of the Central Administration
- Jorma Helin, Administration of Traffic Services
- Eini Hirvenoja, Administration of Traffic Services, from 9/98 onwards
- Martin Johansson, Administration of Traffic Services, from 3/98 onwards
- Jouko Kantonen, Administration of Traffic and Road Research
- Pentti Karvonen, Administration of Traffic Services, from 3/98 onwards
- Marja Koski, Administration
- Risto Kulmala, Administration of Strategic Planning, up until 7/97
- Mirja Noukka, Administration of Traffic Services, from 3/98 onwards
- Maritta Polvinen, Administration of Traffic Services, up until 3/98

– Project coordinators
- Yrjö Pilli-Sihvola, Kaakkois-Suomi Region, project coordinator, chairman
- Eini Hirvenoja, Administration of Traffic Services, project secretary up until 9/97
- Bilal Atiye, Administration of Traffic Services, project secretary 10/97-12/97
- Risto Kulmala, expert, Technical Research Center of Finland (VTT) from 8/97 onwards
- Jukka Lähesmaa, Technical Research Center of Finland (VTT) deputy coordinator from 1/98 onwards
- Anna Schirokoff, Technical Research Center of Finland (VTT) project secretary from 1/98 onwards

2.4 Information and reports on programme

Information on the programme was distributed both in Finland and abroad. One English and four Finnish pamphlets were written on the programme and distributed widely. These pamphlets make up Appendix 1. The programme was also the subject of several leaflets, and an introductory video in four different languages. The programme and its subprojects were presented at several international conferences. The leaflets and papers are listed in Appendix 2.

The programme group monitored the development of the projects through briefings. Prior to programme group meetings, the project secretary collected all data on the development of the projects and wrote them down on the briefing. A total of 11 briefings were drawn up during the programme. The briefings were also used to inform the steering group of the programme of recent developments. In addition to the briefings, the development of the projects was also monitored with the use of tables, which outlined the stages the projects were in.

Most of the projects have been represented in either a report or a memo. Appendix 2 contains a list of all reports and memos produced in the programme. In addition, Appendix 3 contains abstracts of all the project reports.

On March 18 1998, the final seminar of the programme was held in the conference wing of the Helsinki Fair Center. The seminar outlined the work done on the E18 test area in connection with the development of data collection, information management, information systems and traffic control, as well as assessments of the practicability and impacts of the systems. The seminar was meant for Finnra's partners, representatives of road users and Finnra personnel who were in charge of traffic efficiency, traffic control, information services and traffic safety.

This final report on the E18 test area outlines the collected results and follow-up actions of all the projects carried out on the test area. An examination of the experiences gained through the projects was used to formulate an image of the lessons learned about collecting, processing and distributing traffic data as well as the impacts of this data. These experiences formed the basis for a definition of the ways in which transport telematics should be developed and utilized during different traffic conditions on various types of roads in Finland. The project also examined the own ideas of the project participants concerning the benefits and disadvantages of combining individual projects into the E18-programme.

2.5 Programme costs

The overall costs of the programme were approximately 29 MFIM. About 13 MFIM of this was spent on research and development, while 16 MFIM was spent on investments. The division of investments costs to road regions were 5 MFIM for the Uusimaa Region, 4 MFIM for the Turku Region and 7 MFIM for the Kaakkois-Suomi Region. The central administration funded the R & D -operations.

Many of the projects included in the E18-programme have also been part of the European Union's VIKING-project. Hence, the E18-programme and most of its projects have received TEN-T (Trans-European Networks - Transport) funding allocated for the development of the European Union´s basic transport infrastructure.

3 PROGRAMME AREAS

3.1 In general

The following outlines the aims, main findings and recommended follow-up actions of the projects included in the test area programme for each programme area. There is also a summary of each programme area, containing the main results and recommended follow-up actions from the projects belonging to the area. Furthermore, topics that at the end of the programme were considered to be connected to the programme, are mentioned in the summaries. The summary of the Impact evaluation –area also presents earlier studies not included in the programme, which have provided knowledge that has been used in the definition of the Finnish transport telematics solution (Chapter 4).

The findings and recommendations are based on information obtained through People who were in charge of the projects, and on a discussion on these projects during the programme group seminar on 22.9.1998 and during the regular meetings of the programme group.

3.2 Development of data collection (A)

3.2.1 In general

Table 1 presents the main achievements of each project in the "development of data collection" area, the reports or memos written on the projects, the person who was responsible for the project at Finnra and the organisation which was responsible for carrying out the task.

Table 1. Data collection projects and their achievements, the people in charge and the organizations that carried out the projects

Project		Achievements	Person in charge	Organisation
A1	Thermal mapping of the E18 road	Thermal map of the E18 road Reports: Vaisala (1996). E18 - Thermal mapping report, winter 95/96. Vaisala (1996). E18 - Thermal profile, winter 1995/96.	Yrjö Pilli-Sihvola	Vaisala
A2	Road surface condition classification based on road weather data	Method used in road surface classification Reports: Raitio, J. (1998). Recognition of Weather and Road Conditions for Control of Variable Speed Limits at Kotka-Hamina Motorway.	Yrjö Pilli-Sihvola	Technical Research Center of Finland (VTT)
A3	Enhanced road weather monitoring between Lohjanharju and Salo	Dense network of road weather monitoring stations and a monitoring system Memos: Alastalo, A. Road weather system in the Turku Region between Muurla and Sammatti. Annala, J. (4.12.1998). The Operation of road weather stations on the weather-controlled road between Karhula and Siltakylä 1998.	Juha Ylikorpi	Finnra/ Vaisala
A4	Road weather monitoring using a moving sensor vehicle	A prototype of road weather sensors and data transmitting hardware Report: Lampinen, A. (1998). Mobile road weather monitoring – Developing a probe vehicle for friction monitoring (Safe Drive)	Jukka Savolainen	AL-Engineering
A5	Tracking system for maintenance vehicles	In-vehicle equipment in the 23 winter maintenance vehicles of Turku Region and the central monitoring system hardware at the Turku Road Weather Monitoring Center Report: Kaarto, S. (1998). GPS vehicle tracking in the Turku Region. Turku Road Weather Monitoring Center.	Juha Ylikorpi	Finnra/ Geostar
A6	New road weather and traffic data collecting software	Road weather data collecting software about to be implemented Traffic data collecting software defined Reports: Intrinsic (1998). Windows NT-server software, Functional definition, V2.0.0, 02.01.1998. Intrinsic (1998). Windows NT-collecting software, Planning document, V1.0.0, 07.01.1998.	Jouko Kantonen	Finnra/ Intrinsic
A7	Road weather camera images into the road weather system	Road weather camera images from the entire country on the server of the road weather system Memo: Toivonen (1997). Road weather camera images from the E18 road into the road weather system.	Kimmo Toivonen	Finnra
A8	Image transfer through the data network	Moving digital image now transmitted from four trial sites to the Uusimaa Traffic Management Center Memo: Rajala, P. (18.11.98). Digital image transfer.	Pekka Rajala	Remtec
A9	Collecting data on traffic incidents and accidents	The exchange of data among different authorities agreed on Memo: Helin J. (22.12.98) Collecting data on traffic incidents and accidents	Jorma Helin	Finnra
A10	Development of traffic monitoring based on digital image processing	One piece of image processing hardware having a trial run	Pekka Rajala	Finnra

3.2.2 Aims, main achievements and recommendations

A1) Thermal mapping of the E18 road

The thermal mapping of the E18 road measured the changes in the road surface temperature on the test area with the aid of a monitoring vehicle. The project also concerned the acquisition of data on the practicability of thermal mapping in traffic information services.

Thermal mapping was used to help in choosing the best location for the dense road weather monitoring network, and to make the data supplied by the stations more widely useable in both traffic information services and road maintenance.

The project produced a report on thermal mapping and a number of thermal maps of the E18 road, which were used to determine the optimal locations for stations along the test road section between Lohjanharju and Salo. The thermal mapping report and thermal maps were used on the test road section between Pyhtää and Kotka to decide on the locations of stations and to define road sections that would have road weather-controlled speed limits.
Thermal mapping can and should be used to draw up a basic map of the thermal conditions on a road section, which has variable conditions. The further use of thermal mapping data in traffic information services calls for the further development of data processing software used in the information services.

Changes in the thermal profile of the road could also be monitored e.g. on the basis of data obtained through the surface temperature sensors in a monitoring vehicle. If the previous thermal profile is no longer accurate, the thermal mapping should be redone.

A2) Road surface condition classification based on road weather data

The project was about increasing the accuracy of the data on the road surface condition that is used in traffic control. The aim was to find a method in which the control system would classify the current road surface condition reliably and in such a way that the speed limit is, as often as possible, suitable for the conditions, and does never exceed the appropriate level.

The road surface classification with three classes that was used to control the weather-controlled road between Kotka and Hamina from 1994 to 1997 was found to be in need of improvement in order to make the speed limits to better suit the road conditions. The old road surface classification occasionally gave erroneous results. The project developed a method through which a road surface class to best suite the road conditions is determined by analyzing road weather data with statistical methods. This method improved the quality of road surface classification in comparison with the road surface classification used on weather-controlled roads and the one designed by experts. The method as well as the definition of the road surface classification should be developed further.

A3) Enhanced road weather monitoring between Lohjanharju and Salo

The road between Lohjanharju and Salo is very hilly and the road surface conditions vary a lot. The aim of the project was to increase the accuracy of road weather data on a problematic road section and to examine whether enhanced monitoring would help to manage these kinds of conditions.

The project examined the viability of a new data transfer method and a new station type and obtained, installed and tested new road weather stations. The test area passed through two road regions, the Uusimaa and Turku Regions, which allowed the development of inter-regional co-operation.

The road section has 50 operational new-type road weather stations. The old types of stations required independent telecommunication connections to the data processing system. The new type of station can have so-called slave stations, which transmit data only to the main station. The main station has a link to the data processing system. The technical operation of the system has had its deficiencies. The new data transfer method became operational after repairs. The road surface analysis carried out by the road weather stations is, however, not sufficiently reliable at the moment. The analyzing program is still under development.

The functioning of the road weather stations and the road surface analysis they carry out must be developed in order to get the maximum benefits from the investment. Expanding the network of road weather stations to include other road sections is currently not advisable due to the technical difficulties.

A4) <u>Road weather monitoring using a moving sensor vehicle</u>

The objective of the project was to develop road surface condition and weather detection and monitoring systems as well as friction measurement on the road sections between road weather stations. Prior to the implementation of the project, road weather data was only collected at road weather stations. Making generalizations about road surface and weather conditions between the stations based on data collected at the road weather stations was found to be difficult.

The project concerned the construction of a sensor vehicle for collecting data on friction, the temperature and moisture conditions.

The transmitting of friction, temperature (air and road surface) and moisture data as well as a video image from a moving vehicle to the road weather system at a Road Weather Monitoring Center is now operational, but the road surface temperature sensors are not sufficiently accurate yet. The data is presented in a WinNT User Interface for RWIS.

In the winter of 1998-99, the vehicle should be kept on the road as much as possible in order to find out the applicability and reliability of the collected road weather data. After the practicability of the system has been confirmed, the system should be developed in order to make it viable for mass production as a package that can be easily installed in heavy vehicles.

A5) <u>Tracking system for maintenance vehicles</u>

Prior to the implementation of this project, Road Weather Monitoring Center personnel would have to call the drivers of maintenance vehicles in order to get data on the location of the vehicles and the current status of the maintenance work. The objective of the project was to make the planning, realization and monitoring of winter maintenance operations easier.

In the fall of 1996, the Road Weather Monitoring Center in the Turku Region began experimenting on vehicle tracking using a GPS system. The movement of the vehicles and the status of the maintenance operations are shown on a map grid at the Road Weather Monitoring Center.

The system has been found to be useful and working well, and it has made winter maintenance control easier at the Road Weather Monitoring Center. The increase of number of GPS and data transmitting equipment from eight to 23 clearly increased the applicability of the system. Data transmitting software has been under development, thus allowing the transmission of data on vehicle locations and current maintenance actions and making the aforementioned data reliable and up-to-date.

The system should be expanded and made to include as many vehicles as possible. It is recommended that the announcements on current maintenance actions are made automatic.

A6) <u>New road weather and traffic data collecting software</u>

The old road weather and traffic data collecting software could only collect data from fixed road weather stations. The opportunities for collecting traffic data were limited, and traffic data collection was not widely used. The aim of the project was to make possible the collection of data from different types of stations with one piece of software. The new data collection system was needed for instance for project A3 ”Enhanced road weather monitoring between Lohjanharju and Salo”.

The project defined and implemented software which enables the collection of traffic data from both fixed and mobile monitoring stations and the transmission of data concerning errors in Variable Message Signs. The data system collects, processes and records data on traffic conditions for various uses. E.g. the Road TIC personnel monitor the traffic situation, and traffic data is also used for manual and automatic traffic control. The system enables the transmitting of data to other systems, such as Internet services. The software also enables the collection of data using either centralized, partly decentralized or decentralized systems.

Data collection at road weather stations became operational in the June of 1998, and the technical definition and implementation of collecting software for data from traffic monitoring stations and road weather camera images was ordered at the same time. The software was scheduled to be delivered in early 1999. After delivery, the software was implemented nationwide in the winter of 1998-99. The old system will be completely abandoned by the fall of 1999.

The software should be supplemented with software for determining traffic control recommendations during the year 1999. The determining of recommendations can be used in controlling variable message signs or sending messages via traffic information services automatically.

A7) <u>Road weather camera images into the road weather system</u>

Prior to the implementation of this project, data transmission costs were great, because the road weather camera had to be contacted separately every time an image was needed. Besides images from their own road weather cameras, road regions often needed data on the roads in neighboring road regions in order to predict approaching weather fronts and carry out maintenance operations in a way that road surface conditions would not change on the borders of road regions.

The aim of the project was the common use of all Finnish road weather cameras at all Road Weather Monitoring Centers and Road Traffic Information Centers and the implementation of similar procedures for collecting and distributing road weather camera images at all road regions along the E18 road.

The project acquired a shared server and the images from data collection PCs are transmitted to the server via the telecommunications network. Road weather camera image collection PCs collect images via a normal optional phone line. The road weather camera images from the entire country (about 80) are placed onto one server and can currently be accessed on Finnra's Intranet. The images taken with new different types of cameras will probably be in general use in the late winter of 1999.

A8) <u>Image transfer through the data network</u>

Various monitoring stations give accurate and exact numerical data on traffic and road surface conditions within the road network. Numerical data on road conditions can be supplemented and illustrated significantly with images. The objective of the project was to study the possibilities for transmitting a real-time video image through the data network and to examine the applicability of a digital, slowly updated video image.

The project involved testing the transmission of a digital video image from the road to the Road TIC at four test sites. The picture quality was high with analogous image transmitting techniques, but the quality of the digital image was also considered to be high enough for use at Road TIC. The quality of the digital image depends on the data transfer packing techniques and the data transfer capacity, and the quality will not deteriorate even with long transfer distances. A digital video image is also ideal for still frames. Digital image transfer allows the positioning of a lone camera even at secluded and remote locations at lower costs than using analogous technology. However, if the same road section requires several cameras, it is cheaper to use analogous image transfer. Digital data transfer thus complements the other data collection methods, but does not replace them.

The trial should be continued on a small scale while waiting for the costs to decrease as technology develops further.

A9) <u>Collecting data on traffic incidents and accidents</u>

For two years prior to the E18 programme, a RDS traffic information system involving the police, the Finnish Broadcasting Company and Finnra had been in use. The system supplied information annually on about 300 accidents or other incidents that caused traffic problems. Numerous studies indicated, however, that significantly more situations affecting traffic happened annually, but were not announced during any traffic information bulletins. Getting the information to drivers also often took too long.

In order to improve data collection and to speed up data transfer, decisions were made to increase the details of police guidelines and to simplify data transfer between the police and Finnra, and consequently to the Finnish Broadcasting Company and other radio stations. The police, regional fire brigade centers, radio stations and Finnra duty personnel were instructed on the new procedures at ten regional events in 1997.

The most important changes involving data collection were
- changing from faxes to phones in reporting, and having a single nation-wide phone number for these services
- information services fully becoming Finnra's responsibility day and night. The country also saw the introduction of a network consisting of nine Road TICs and one national information center.
- Finnra being assigned full responsibility for the data and its distribution

In 1997, there were trials carried out on co-operation on data collection by Road Assistance Service in the Lahti region. This co-operation expanded nationwide in 1998 and currently involves about 350 Road Assistance Service Patrols. The Road Assistance Service personnel were also trained in the system, and training is now a prerequisite for being allowed to transmit data.

Message composing and transmission software was designed in order to speed up data transfer. A direct connection between Finnra and the Finnish Broadcasting Company's transmission system was also set up. The software also involves the sending of faxes with the same data content to local radio stations and radio Nova.

The collection and transmission of incident data was closely connected to examining the possibilities of the traffic management service database. The collection of incident data was closely connected to "Functional analysis of Road Traffic Information Centers" project and the definition of the need and methods for transmitting incident and other traffic-related data that was implemented especially around the capital city.

The amount of traffic incident messages was in 1997 three times greater than earlier, at least partly due to more specified responsibilities, faster and less complicated data transfer methods and the training given to duty personnel. The amount of accident and other incident data increased a further 30 percent in 1998.

Despite the improvements in incident data acquisition, data coverage has to be further developed e.g. by expanding the task of data collection to include professional drivers. The reliability and speed of information services also require a joint development effort from all participants. The immediate broadcasting of incident data through local radio stations should be secured with contracts. Road

TICs should be provided with a common and consistent information system for registering incident data. The authority radio network (VIRVE) will also be used from the early 21st Century onwards as a channel for transmitting incident data under normal conditions. A trial run of this will be started in 1999 in southeastern Finland.

A10) Development of traffic monitoring based on digital image processing

Finnra wanted to test alternative methods for monitoring traffic. The objective of the project was to study the practicability of traffic monitoring based on digital image processing in Finnish conditions. The project started with the selection of a system based on video image processing for the trial.

The equipment based on digital image processing was found to be functional, and its costs are similar to those of a loop detector system. The system is at its best at locations where incidents have to be identified quickly, e.g. in tunnels.

In the future, the utilization of image processing should focus on systems based on incident detection and incident management. The image processing equipment currently on the market should also be examined.

3.2.3 Summary

Main achievements

New traffic and road weather monitoring stations, including mobile ones, have been tested and their functioning has been improved. Road weather and traffic data can now be collected more extensively, and Road TICs have access to a greater variety of data.

The new data transfer methods allow the transmission of data also from moving vehicles and individual measurement points at a lower cost than before.

The new road weather data collecting software functions and it can now be implemented more widely. Images from the road weather cameras on the E18 area have been placed onto a common server and can thus be used by all Road TICs. The software for collecting data from traffic monitoring station has been defined and the collection of data will begin shortly. Road weather and traffic data collecting software makes it easier to process and combine different types of data, as all data that is in a form that complies with the definition can be processed by the same system.

A functional tracking system for maintenance vehicles and operations has been developed.

Main recommended follow-up actions

- Finalizing the project on road weather and traffic data collecting software
- Developing road weather analysis by improving road weather monitoring and the analysis of road surface condition data
- Examining the viability of friction monitoring using probe vehicles
- Developing camera monitoring of road surface and traffic conditions
- Developing the automatic monitoring of traffic flow and travel times

- Development of interorganizational co-operation in incident data collection

Studies missing from the programme

- The monitoring of traffic and road surface conditions on the basis of camera images should have been defined more clearly as a separate project
- Traffic monitoring (fluency) was not developed with the weight it deserves in its current role as a prerequisite for traffic control and information services
- Development of the detection of adverse road surface conditions, which are difficult to detect using current methods (e.g. slush)

3.3 Development of information management (B)

3.3.1 In general

Table 2 presents the result of each project in the "development of information management" area, the reports or memos written on the projects, the person who was responsible for the project at Finnra and the organisation which was responsible for carrying out the task.

Table 2. Information management projects and their achievements, the people in charge and the organizations that carried out the projects

Project		Achievements	Person in charge	Organisation
B1	Needs for change in the road weather system, a prestudy	Needs for change in the road weather system have been determined Definition: Finnra and Intrinsic Oy (1995). Needs for change in the road weather system - Prestudy 10.11.1995.	Yrjö Pilli-Sihvola	Intrinsic
B2	Definition and development of traffic management service database	The data needed for traffic management and information services the existing data systems have been defined Reports: Finnra (1997). Description of the logical service database, Finnra internal publications 3/97. Traficon (1998). Functional analysis of Road Traffic Information Centers.	Marja Koski	Finnra Traficon
B3	Definition of technical architecture and uses of the service database	The uses and the operations of Road Traffic Information Center duty personnel have been defined for the phase-by-phase implementation of the service database Memo: Novo Group (26.11.1998). Definition of architectural solutions and uses of the service database / data storage.	Marja Koski	Finnra Novo Group
B4	New register of road works	The contents of the new register of road works have been defined Definition: TITY-redefinition. Finnra, Traffic Service Unit, Tie-Data. 7.6.1996.	Marja Koski	Finnra
B5	Traffic management user interface	User interface of road works information system Memos: Intrinsic (1996). Traffic management user interface. Project plan. Intrinsic (1998). Traffic management user interface - road works information management. Description of interface.	Jorma Helin	Intrinsic
B6	Road surface condition model	Development of road surface condition models used in traffic information services is made possible Report: P. Saarikivi (1996). Road surface condition models, A study for Finnra 31.3.1996	Yrjö Pilli-Sihvola	Saarikivi W&L
B7	Availability of weather model data	Weather model data needed for Road surface condition model is available Report (for internal use only): Saarikivi Weather & Law Oy (1996). Availability and prices of weather model data, Viking-study for Finnra	Yrjö Pilli-Sihvola	Saarikivi W&L
B8	Development of road surface classification for controlling variable speed limits	Methods for controlling European variable speed limits have been determined Report: M. Nesti, editor (1998). Report on Improved and Validated Automatic Test Sites. TROPIC deliverable D9.4.	Yrjö Pilli-Sihvola	Technica l Researc h Center of Finland VTT

3.3.2 Aims, main results and recommendations for continuation

B1) Needs for change in the road weather system, a prestudy

The road weather system was designed to serve Finnra's road maintenance operations. The E18 programme required more road weather data than before for traffic information services and traffic control and the old road weather system was not meeting these needs. The study examined the general needs for change connected with data collection, the database, the distribution of data and the user interface while taking into consideration the needs of winter maintenance operations, information services and traffic control.

After the prestudy had been completed It was found that the needs for change should be defined in greater detail before making any changes according to the defined needs. These needs should also be checked to correspond with the current operational environment. This check was carried out in project (A6) "New road weather and traffic data collecting software".

B2) Definition and development of traffic management service database

Traffic management utilizes several data systems for different tasks. The objective of the project was to define an information system, which would combine these several separate systems, thus promoting the creation of joint traffic information and control services. The *"Description of the logical service database"* report describes the operational environment the new management system is needed for. The project also presents ideas for the new system. The project defined the data needed by the various traffic management and information services, and described the existing information systems. The traffic management database is primarily based on other data systems and data storages (e.g. traffic, road weather), and utilizes information obtained from these units.

The definition of the traffic management service database was a very extensive task. The extent of the task itself hindered the progress of the project. It was recommended that the definitions of the various systems should be more detailed in the future and should be accepted as part of Finnra's traffic management systems architecture.

After the traffic management service database had been defined, the prestudy and definition work were continued in a variety of ways:

- The operations of Road TICs were described in great detail and modelled for the management of various incidents on the road network. This task formed the basis for the publication *Functional analysis of Road Traffic Information Centers.*
- The umbrella project TIVEKO (control of the road network use) was founded to develop management systems for the central processes of Road Administration
- It was decided that the traffic management user interface and the processing of incident data should be described alongside the service database.
- The Road Traffic Information Center pilot being carried out in the Oulu Region was observed. As the pilot system was extensive and was close to the national service database –idea, an outside evaluation of the software was commissioned. The project concerned the evaluation of those sections of the pilot system, which could be utilized nationwide.
- Data exchange between Road TICs in other countries was developed as a

Viking-project. The Viking working group examined e.g. the DATEX data exchange standard and, based to that, the database model, incident classifications, the location database, illustrating data on a map grid and the possibilities presented by the Internet.

B3) Definition of technical architecture and uses of the service database

In order to produce a traffic management service database, a project was created for defining the technical architecture and uses of the service database on the basis of a description of the traffic management service database and a functional analysis of Road TIC.

In the project, the basic architecture describing the data storage needed for traffic management and its relationship with other data systems was formulated. The work included a concept inventory describing e.g. the characteristics and links with other data of the main concepts connected with traffic management, such as carriageway, lane or speed limit. The basic architecture demands that each piece of information in the data storage has have a documented rule concerning the formulating of the data, i.e. from where the information has been received and in which form it should be.

The uses describe the operation of the system from the user's point of view, i.e. the dialogue that takes place between the user and the system during a variety of tasks. The uses are outlined in six categories:

- Data collection (data coming from the systems, the recording of events, the formulation of prognoses)
- Monitoring the situation (the view of duty personnel to the data)
- Support functions (data management, upkeep of support data and regulations, supervision e.g. with the help of the Road TIC diary and logs)
- Distribution of data (information services for road users as well as internal and external co-operating parties, data exchange)
- Traffic control
- Incident removal (removal of the cause of an incident, e.g. a broken-down vehicle, from the road).

A forum outlining the project's findings and using these findings as the basis for a discussion on Finnra's basic service database and data storage policy was arranged at the end of the project.

The next step should be realizing the service database in accordance with the project design. The system is designed to be implemented in phases. The first systems to be implemented include the recording of data on traffic events, the recording of events taking place at the Road TIC in a diary, incident information services for radio stations, a customer database and a work place for Road TIC duty personnel.

B4) New register of road works

The old system for registers of road works no longer sufficiently accommodated the new demands. Hence, a new system was needed. There was a desire to expand the contents of the register and to provide a consistent, unified register for the whole country in order to allow the spokesmen to provide data on road works in other regions. There was also a desire to provide information through new media, such as the RDS-TMC- and GSM-systems, the use of which was outlined for the first time. The result was a report outlining the new operations model and contents of the register of road works. The users of the register of road works, the producers of the data, the links with other systems and the use of the register in information services in various media were also outlined.

The task was continued with project B5, which involved the implementation of the new register of road works applying the traffic management user interface.

B5) Traffic management user interface

Finnra's nine Road TICs and one national Traffic Information Center needed a unified data system, called a traffic management user interface, to process and present general traffic information. The aim was to be able to feed in, update or remove traffic data from the road works database at any center and to be able to see the traffic data almost simultaneously at all the other centers. Personnel should be able to look at data represented by symbols or e.g. roads marked with different colors according to their various characteristics on the map grid of the user interface.

In the project the general plan of the traffic management user interface was made and road works system was selected for implementation. Road works were chosen first because there was no point in amending the old register any more and because the road works data had just been redefined. In addition to this, the system for processing data on road works is needed at all Road TICs. Data on road works is required for numerous information services e.g. on teletext, on the Internet and at information kiosks, and data is also sent to radio stations, newspapers and the other Nordic countries.

The implemented traffic management user interface is used to feed in, scan, update and report on national and regional data on road works. The reports can also be automatically generated in Swedish and in English. The feeding-in and updating of data are usually carried out with forms, but can also be done directly on the map grid. The map is most useful to use when serving a road user on the phone. The map symbols allow easy access to the correct road works and its real-time data. The system allows the possible map display of e.g. only the road works that are affecting traffic at the time of the query.

The realization of the traffic management user interface showed that the implementation of such an extensive and nationwide system requires a lot of testing and training. On the other hand, a common, uniform information system promotes data equal in quality and enables the utilization of the network of Road TICs. The implemented part of the user interface can be used in traditional road works information services, but not very well in connection with a situation that changes daily or even hourly. We therefore suggest the foundation of a new project to define in greater detail the users' needs in processing real-time information.

The implementation of the road works information system also indicated that the traffic management user interface should be implemented system-by-system being prepared for constant changes in the technical environment.

B6) Road surface condition model

The objective of the project was to find out whether it is possible to construct road surface condition models for use in traffic information services that can function automatically in Finnish conditions. Road surface condition models are used to predict the road surface condition at a specific moment. The bases for the development of the road surface condition models are accurate weather forecasts and data on road conditions.

The developmental possibilities of an advanced and functioning road surface condition model are excellent. In Finland the development of weather models used to predict the weather is one of the best in the world. The geographical accuracy of the models will be further improved within the next few years. The dense networks of road weather stations and radars provide good basic observations for use in weather and rain forecasts. Thermal mapping also produces viable basic data for the models.

Thermal mapping is recommended to be carried out throughout the entire Finnish road network. The development of an advanced road surface condition model should be started as a separate project within the next few years. The model would serve both traffic information services and the control of winter maintenance operations.

B7) Availability of weather model data

The development of road surface condition models calls for weather model data describing the weather conditions at various geographical sites as a time series. One wanted to look into the availability of this data from various sources for use at Finnra. The annual costs of weather model data were estimated to be between 0.5 and 1.5 MFIM, depending on the amount of model data needed. The costs of weather model data are not an obstacle for the development of Finnra's own road surface condition model. Instead, there will be savings in comparison to the current road surface condition forecasting service bought from the Finnish Meteorological Institute.

The Nordic HIRLAM was assessed to be the best weather model, with data that could be used in constructing a road surface condition model. The possible suppliers include the Finnish Meteorological Institute, the Swedish SMHI and the Danish DMI.

B8) Development of road surface classification for controlling variable speed limits

The aim of the project is to improve the recognition of road surface conditions on the basis of monitoring data collected by road weather stations, which acts as the basis for road weather-controlled speed limits. The project formed part of the European Union's TROPIC-project. It concerned the studying of the operation of the systems of currently used variable message signs and the development of automatic control methods. In Finland, the Road surface classification based on road weather data –project (A2) worked as the pilot project.

The follow-up recommendation is that the use of road surface classification should be expanded to also include those road sections that do not use variable message signs. A classification corresponding with the model would be used to produce information to act as a basis for the traffic information services. Road surface classification can also be used to promote decision making at Road Weather Monitoring Centers as regards winter maintenance operations.

3.3.3 Summary

Main achievements

The overall system needed for the processing of information connected with traffic management and the connections between the various parts of the system were defined during the E18 programme. These definitions allow the system to be implemented systematically.

A new approach to information management was discovered whereby several separate systems are combined into a traffic management service database. The E18 programme has promoted the use of this approach within Finnra.

During the programme the operational environment of traffic management operations was found to be changing so rapidly that the systems will have to be implemented in phases.

The modelling of traffic and road weather data can improve the quality of traffic management operations and expand the utilization of data to new areas.

A new method and a new tool were discovered for the management of information on road works and the associated information services. The utilization of the tool has given information on the practical pros and cons of a system that covers the whole organization and is linked to a network.

The know-how of transport system professionals has improved and the number of people who are knowledgeable as regards the field has increased with the implementation of the projects.

Main recommended follow-up actions

The implementation project or projects should be carried out in accordance with the development plan of the traffic management service database. The more detailed definition and implementation of the sections of the service database should be carried out in phases.

The development of modelling should be continued. Important development projects in modelling include both road surface condition models and traffic models. These models should be used to develop e.g. travel time predictions. The utilization of those models in traffic control and information services should also be examined.

Information obtained from outside Finnra (e.g. from the police or road users) should be added to the traffic management service database when needed. The adaptation of this information into a form that can be utilized should also be developed.

Studies missing from the programme

The E18 programme did not examine rapidly changing status data, i.e. information on e.g. traffic flow, incident situations or maintenance operations that are proceeding rapidly. The provision of data on these situations for the traffic management service database and the processing of data to form an idea of their impact e.g. on the travel times of road users will be important items to be developed in the future. The processed data will be utilized in traffic control and information services.

3.4 Development of distribution of data (C)

3.4.1 In general

Table 3 presents the result of each project in the "development of distribution of data" area, the reports or memos written on the projects, the person who was responsible for the project at Finnra and the organisation which was responsible for carrying out the task.

Table 3. Data distribution projects and their achievements, the people in charge and the organizations that carried out the projects

Project		Achievements	Person in charge	Organisation
C1	Concept for traffic information kiosk	Definition of the information kiosk concept Report: Finnra (1998). Traffic information kiosk concept "the New Tie-info", Finnra internal publications 25/1996.	Maritta Polvinen	LT-konsultit
C2	Pilot information kiosk at Ouluntulli	Information kiosk at Ouluntulli Memos: Oulu Region (1997). Ouluntulli pilot: Internet-based information service for road users, interim report 12/97. Oulu Region (1998). Ouluntulli pilot: On-line information service for road users, final report 9/1997: Summary of findings.	Markku Tervo	Oulu Region
C3	Car ferry traffic information services in the Turku Region	Information monitor on one car ferry Report: Vägverket, Finnra (1997). Pre-study project Ferry. (information on car ferries)	Pekka Liimatainen	Turku Region Finnra
C4	E18-demo	Multimedia demonstration on the Internet Report: Nurminen, I. (1998). Road weather information multimedia demonstration. Finnra internal publications 27/1998	Yrjö Pilli-Sihvola	Saarikivi Weather & Law
C5	WIND	Tienkäyttäjän Internet-palvelu määritelty Raportit: Tervo, M., Tervonen, R. (1997). WIND On-line Service Behrendt, F., Schedler, K., Scheiderer, T., Tervo, M., Tervonen, R. (1997). WIND (Weather Information and Distribution Services) Report for Publication.	Markku Tervo	Oulu Region
C6	Implementation of real-time traffic information service homepage	Internet service for road users http://www.tieh.fi/alk/	Maritta Polvinen	Finnra Weather Service Finland
C7	RDS-TMC –service in the E18 area	The RDS-TMC –service chain is operational and the service is available in the test area	Martin Johansson	Finnra, Finnish Broadcasting Company
C8	PROMISE, GSM-traffic information services	Information service for several transport modes in the test area Reports: Reports in English can be downloaded from http://www.promise.cellulardata.com or requested by e-mail from PROMISE@nmp.nokia.com	Sami Luoma	Nokia, VTT, Novo Group, Sonera, Finnra
C9	Variable speed limits at the Uusimaa Region	Variable speed limits in use on highway 1 Planning folder: Highway1, variable message signs between Lohjanharju and TPR.	Pekka Rajala	Uusimaa Region
C10	Variable speed limits at the Turku Region	Variable speed limits covered up and in trial use on highway 1	Juha Ylikorpi	Turku Region
C11	Variable speed limit trial on road between Pyhtää and Kotka	Variable speed limits in use on highway 7 Report: Kauste, E. et al. (1998). The extension of the weather controlled traffic management system for E18 road between Kotka and Pyhtää, Summary report. Kaakkois-Suomi Region, Traffic Services	Yrjö Pilli-Sihvola	Kaakkois-Suomi Region Kymen Viatek Oy

Continuation

Project		Achievement	Person in charge	Organisation
C12	Combinations of variable warning and information signs on the roads between Salo and Lohjanharju and between Pyhtää and Kotka	Variable message signs in use on highway 1 in the Uusimaa Region and on highway 7 in the Kaakkois-Suomi Region Variable message signs covered up and in trial use on highway 1 in the Turku Region Planning folder: Highway1, variable message signs between Lohjanharju and TPR. Report: Kauste, E. et al. (1998). The extension of the weather controlled traffic management system for E18 road between Kotka and Pyhtää, Summary report. Kaakkois- Suomi Region, Traffic Services	Juha Ylikorpi Pekka Rajala Yrjö Pilli-Sihvola	Turku, Uusimaa and Kaakkois-Suomi Regions Kymen Viatek Oy
C13	Trial of improved software for road surface condition classification in control of variable speed limits on the road between Kotka and Hamina	The trial has not been started yet	Kimmo Toivonen	Kaakkois-Suomi Region
C14	Operating principles of variable road surface condition message signs and the maintenance and construction principles of these systems	Definitions of operating principles and system maintenance principles Reports: Toivonen (1997). Weather-controlled road, recovery plan for the technical building. Finnra. Toivonen (1997). Weather-controlled road, data security survey. Finnra. Finnra (1997). Weather-controlled road highway 7 (E18) between Siltakylä and Summa. Controlling principles of variable message signs. Kaakkois-Suomi Region, Traffic management and Services	Kimmo Toivonen	Kaakkois-Suomi Region
C15	Hypermedia presentation of weather-controlled road	http://forum.inet.fi/tielaitos/hypermedia/aloita.html http://192.83.40.211/hypermedia/aloita.htm Memo: Toivonen, K. (1998). Hypermedia presentation of weather-controlled road. Finnra.	Kimmo Toivonen	Kaakkois-Suomi Region

3.4.2 Aims, main achievements and recommendations

C1) Concept for traffic information kiosk

Finnra implemented a few information kiosks in the early 1990's. They varied from one another and were technically outdated already when the E18 programme started. The aim of the project was to create a uniform concept for the utilization of information kiosks. The project defined the ideal network of different information kiosks and the role of the information kiosks among Finnra's services. The contents of the services of the information kiosks and the technology used at the kiosks were also examined.

The report unearthed the need for information kiosks, but also problems associated with implementation of the kiosks. The project on the information kiosk concept and the information pilot kiosk at Ouluntulli (project C2) indicated that the Internet is a good channel to use in the implementation of the information kiosks. Presenting the contents of the services on a map grid is a good solution. A consistent policy is needed within Finnra for the realization of the information kiosks, but slight alterations in the contents of the information kiosk services in different regions should be allowed.

The essential services provided at the information kiosks and the ideal user interface should be defined. Information kiosks corresponding with the new concept will be tested and a network of information kiosks corresponding with the definition will be created. In the future, information will be shown on a map grid and the provided services will also include route planning.

C2) Pilot information kiosk at Ouluntulli

The Oulu Region started the pilot information kiosk project in response to its own needs. The project was included in the E18 programme to make the information collected during the project available for wider use.

The objective of the project was to study, test and create facilities for Internet-based services for road users. The objective was also to find out what kind of regional co-operation could be carried out in the provision of services with other parties, such as the authorities and media. The pilot also experimented with the use of a map grid to illustrate data.

The project confirmed that the Internet is the correct channel to use in the implementation of the information kiosks. The project also outlined the problems associated with the implementation. The map base and route planning included in the project are good characteristics, but at the moment there are still technical problems with the utilization of the map. The service should concentrate on producing a limited amount of high-quality data and not try to include too many elements in the services.

The results of the pilot will be taken into consideration during the development of the national concept of information kiosks and the testing of these kiosks.

C3) Car ferry traffic information services in the Turku Region

The aim of the project is to find a way to provide drivers of both passenger cars and heavy vehicles with information on road surface conditions, routes, accidents, etc. The project aimed to develop a functioning system to serve the passengers by utilizing material already produced for Finnra's and Vägverket's web pages. The project was a co-operative effort between the Swedish and Finnish National Road Administrations. The information requirements of drivers of heavy vehicles were studied in the beginning of the project.

The ship chosen for the pilot was the Silja Europa (Turku-Stockholm route). Traffic information is transmitted onboard the ship via the TV-monitors. The ship's passenger info (TV screens) contain a slide show displaying traffic information. During the first phase of the project, the information was updated daily at the port. In the next phase, there will be an attempt to transmit data to the ship's monitors in real time directly from the Finnra web site.

The pilot was used to obtain information on the desired contents and net-to-ship transmission of information services. The implementation of an interactive information kiosk is difficult on a ship due to the risk of vandalism. Hence, information has to be displayed on a monitor. In the future, further studies should be carried out on financial arrangements and the work of the producers of this value added service in the implementation of the service. The technology used in the implementation should be developed, after which the service should be expanded to include all shipping companies and lines.

C4) E18 demo

The project involved the creation of a multimedia demonstration for the Intranet, containing up-to-date and automatically updated road surface condition information on the E18 road. The information is displayed by showing a car driving down the road. As the car moves along the road, road surface condition information is displayed on tables and with different colored flags. The travel time, length of the trip and fuel consumption are also displayed. The user can select the places of departure and destination, the vehicle type and the speed. Trial users considered the software to be for the most part adequate, though there were some suggestions made for improvements.

Any new software to be distributed via the Internet should first be tested on Finnra's Intranet. The pages should also be placed on the Internet to get feedback from outsiders.

C5) WIND – Weather Information and Distribution Service

The WIND project, a part of the INFO 2000 programme included in the EU's 4th framework programme, defined an on-line service offering real-time information for road users. The solution recommended the displaying of all information on map grids and the use of a variety of maps in different scales for each area. The pilot information kiosk at Ouluntulli (project C2) is a trial for this service concept.

One recommended follow-up action was the creation of a national file for map data designed to meet the needs of traffic information services in Finland. Finnra could maintain and update the information concerning the characteristics of public roads within this service.

C6) Real-time traffic information service homepage

As the Internet becomes more commonly used, there was a desire to define and create a real-time road traffic Internet-service. The result of this project is an online service containing information on road weather, the traffic situation, road works, ferry traffic and variable traffic control operations. The project found that the Internet provides ample opportunities for creating traffic information services. The service was implemented in November 1998.

The Internet-service must be maintained and developed in the future. The design of the web site should be updated maybe annually. The system in charge of the contents of the service must have a link to the traffic management service database. The link will allow the automatic updating of information on the basis of information contained in the service database.

C7) RDS-TMC-service in the E18 area

RDS-TMC is a new Pan-European traffic information service aimed at improving and increasing the amount of data provided for drivers during the trip. The European Commission supports the implementation of the service within the Trans-European Road Network through the FORCE–ECORTIS projects.

The collection of road weather and traffic data has been implemented extensively on the E18 test area, so it was chosen to be also the Finnish RDS-TMC test area. The aim of the project was to construct an RDS-TMC service chain (from data production to data receiving), to define the contents of Finnish RDS-TMC services and to implement the service on a trial basis.

The project involved the construction of an RDS-TMC service chain corresponding with European standards. The Pan-European event list has been translated into Finnish. A system of traffic information service place-names has also been created for main roads. The Crusader system for recording incident data, developed by the Swedish National Road Administration, has been implemented, the Finnish Broadcasting Company's RDS distribution network has been updated for TMC broadcasts, and vehicle terminals have been installed in test vehicles. The construction of the service chain has been a challenging task, as each part of the chain as well as the connections between these parts must all function properly in order for the service to be high in quality.

In the future, the project will concentrate on the further development of the contents of the service. The automatic broadcasting of RDS-TMC messages will be implemented as regards the traffic management service database. The service will be expanded to cover all of Finland during 1999.

C8) PROMISE, GSM-traffic information services

The EU project PROMISE ran trials on the transmission of data on various modes of traffic to GSM mobile communicators. Finnra's aim with the project was to test the transmission of road weather and traffic data to producers of added value services. There was also a desire to obtain real experiences on the use of GSM traffic information services and the functioning of the passenger information service during the trial period. Finnra's role in the service concept was primarily to act as a producer of information and to provide the service with road weather data from the E18 road and information on the traffic situation from the measurement points in the area around the capital.

The trial period showed that there is need for value added services in which data is provided at user demand independent of time and place. Route planning as regards the use of public transportation was considered to be an especially important service. During the trial, road weather data was considered the most important information produced by Finnra. There were especially problems with the transmission of data, as the means of communication (the communicator) was often found to be too slow or unreliable.

The project gave Finnra experience in relaying information to external producers of services, and paved the way for a positive attitude towards the producers of GSM services. The transmission of data from the service database to the producers of value added services will be further developed in the future. Many questions concerning the responsibilities of the producers of information and value added services must be solved as regards the commercial utilization of traffic and road surface condition information.

C9) Variable speed limits at the Uusimaa Region

A system of variable speed limits was constructed on the 8.5-km road section between Lohjanharju and the Turku Region. The section was chosen for the trial, because it has been planned that it will remain a highway for as long as possible as the E18 road is being altered into a motorway. The fiber-optic variable speed limit signs are controlled automatically, in accordance with the speed recommendations based on the road weather system calculations. The speed limits used are 100/80/60 km/h. 11 signs were installed, and they were introduced in April 1997. An ISDN connection was first used to transfer data between the signs and the control center, because such connections had not been utilized before and there was a desire to test the functioning of such a system. ISDN was found to be a good alternative during the trial. With the ISDN, the connection is not constant. Instead, the signs are checked every 15 minutes. In late 1998, the project switched to using a fixed line, as the connection could be built inexpensively. With the fixed line, the signs have a constant communications link with the Road TIC. Systems concerning weather control and determining the recommended speed limit have also been developed, but have not been completed yet.

The monitoring of road surface conditions and the determining of recommendations must be improved before implementing weather-controlled speed limits on a large scale.

C10) Variable speed limits at the Turku Region

A system of variable speed limits has been constructed on the 37-km road section between Salo and the Uusimaa Region. At the end of the E18 programme at the turn of the year 1998/99, the variable speed limits were in trial use with the signs covered. The signs are actually introduced in January 1999.

The road section has 22 fiber-optic speed limit signs, which are manually controlled by duty personnel at the Turku Road TIC. Automatic control can later be implemented, if the road weather stations on the road section will provide more reliable information on road surface conditions in the future. The system includes a technical building, data transfer from which has been realized through cables for some signs and through an internal radio network with two rented radio frequencies for the rest of the signs.

The project has provided experiences in the use of radio control to control message signs. It has been difficult to make data transfer through the radio network to function properly. It has thus been found necessary to alter the planned technical solutions during the trial.

C11) Variable speed limit trial on road between Pyhtää and Kotka

Variable speed limits changing according to road surface conditions have been in use on the single carriageway road section between Pyhtää and Kotka since December 1997. The speed limit, 100, 80 or 60 km/h, is selected automatically on the basis of information obtained from road weather stations. The road section equipped with variable speed limits is about 11 km long. Variable speed limits have been in use on the motorway between Kotka and Hamina since 1994. A total of 66 fiber-optic speed limit signs are in use on the 25-km-long weather controlled road between Pyhtää and Hamina. Variable speed limits will continue to be used on the road section in the future.

Experiences obtained during the construction of this system promote the design and realization of similar road sections. Thunder has damaged signs, thus making lightning protection for the system an important topic for future study. A single telecommunications bus is being used to control all of the signs at the moment. The use of a single bus has been found to increase the chances of malfunction or breakdown. The possibility of using several telecommunications buses to control different sign groups will therefore be examined in the future. The operating principles of the system have been defined in writing, but the monitoring, upkeep and maintenance operations of the system have to be defined in greater detail to ensure that the system will function properly.

C12) Combinations of variable warning and information signs on the roads between Salo and Lohjanharju and between Pyhtää and Kotka

Combinations of variable warning and information signs have been placed in the test area on the road sections, which have variable speed limits. The combinations of variable warning and information signs warn drivers of adverse road surface conditions and other factors that can cause problems for traffic.

The road between Lohja and the borders of the Turku Region has four, and the section between Pyhtää and Kotka has eight variable message signs. Three variable message signs on the road between Salo and the Uusimaa Region are in trial use and covered up. The variable message signs have LED text signs and fiber-optic variable warning signs. The warnings used are "slippery road", "road works" and "caution". The text on the sign (max 2 x 10 characters) can be selected at will. The systems used at the Uusimaa and Kaakkois-Suomi Regions give warnings concerning the weather and road surface conditions automatically on the basis of information obtained through the road weather system. The "slippery road" sign is used to warn drivers about adverse road surface conditions, as the text sign displays a further explanation, such as "icy road". The other warning signals and texts are changed manually. If the text sign has no other message to give, the sign will display the air and road surface temperatures.

C13) Trial of improved software for road surface condition classification in control of variable speed limits on the road between Kotka and Hamina

The aim of the project is to examine the functioning of the improved software for road surface condition classification. A software module for road surface condition classifications on the basis of collected sensor data is constructed to be connected with the sensor data collecting software. The theory, based on project A2 "Road surface classification based on road weather data", is written down as a software code which is used to control the software for road surface condition classification.

The trial for the software has not been started yet. First the new collecting and calculating software must be completed, after which the improved road surface condition classification is added to the guidance system.

C14) Operating principles of variable road surface condition message signs and the maintenance and construction principles of these systems

Guidelines concerning the questions of responsibility and the problems associated with the control and system of variable message signs were drawn up for use of e.g. Road TICs. The guidelines define the actions to be taken when problems occur in order to make the system operational again, and the parties, who are responsible for the functioning of the various parts of the system. The guidelines and operational models are currently in use at the Kaakkois-Suomi Region.

Guidelines concerning the allocation of responsibilities and the actions to be taken in case of problems should be implemented as regards all systems of variable speed limits. The documents should be updated annually.

C15) Hypermedia presentation of weather-controlled road

The project concerned the construction of an illustrative, interesting and easy-to-use hypermedia presentation of the weather-controlled road system at the Kaakkois-Suomi Region for the Internet. The presentation gives people an outline of the system and its operating principles.

The presentation should be kept up to date and it should have a link to Finnra's Traffic Services –web pages which handle telematics, variable message signs, weather control etc.

3.4.3 Summary

Main achievements

The services that were tested during the E18 programme have been found to be useful. At the moment, the exception is the RDS-TMC service, because the necessary terminals are not on sale in Finland yet. The high prices of the equipment, memory cards and CD-ROMs may slow down the expansion of the system even after the terminals are available. Services and distribution networks have to be designed for the various user groups. The services should concentrate on providing a small amount of high-quality service.

The service chain is currently operational and the principles associated with the implementation of the service have been defined as regards most services. The realization of the service chain and the handling of the associated documentation and contracts are very demanding tasks.

Internet technology has been found to work well in the realization of information services for PCs at home and at the office as well as at information kiosks. The displaying of information on a map is pleasant for users, but the use of maps in services still involves technical difficulties, making the use of maps slow or causing malfunctions.

Variable speed limit signs have been installed, they are functioning and they will continue to be used after the trials are over. They have been found to function well and to be accepted by road users in the areas where they are presently in use.

Main recommended follow-up actions

The pan-organizational principles for the use of variable speed limits and information signs will be drawn up. Variable speed limits will be tested on different roads and with a variety of control principles. Any increase in the use of variable speed limits will be decided upon on the basis of experiences obtained through these trials.

The determining of speed limit recommendations will be developed for use in real-time traffic control. Both traffic and road surface condition information will be utilized in the determining of these recommendations.

Information services will be developed to utilize the traffic management service database. The service database should have an automatically updated link to the information services.

The idea of the public-private partnership will be clarified by defining the methods Finnra uses to provide the producers of value added services with the information they require and the types of agreements needed between Finnra and the producers of value added services.

Information services will be developed with the route recommendations on the basis of long- or short-term traffic incidents, such as road works or congestion.

Information kiosks will be constructed in accordance with the results of the ”Traffic information kiosk concept” project, and the RDS-TMC service will be implemented on the entire Finnish main road network. The Internet-services will be maintained and developed. The development of private information services utilizing data obtained through Finnra will be promoted by defining the type of data provided, the method of data provision and the party responsible for the distribution of data.

Studies missing from the programme

The projects included in the E18 programme did not examine active route direction, such as variable route signs or the provision of situation based route information to vehicles. The projects also did not examine the traffic situation based control of variable speed limits.

3.5 Impact assessment (D)

3.5.1 In general

Table 4 presents the result of each project in the "impact assessment" area, the person who was responsible for the project at Finnra and the organisation which was responsible for carrying out the task. The only achievements shown in this table are the reports drawn up on the projects. Abstracts for these reports can be found in Appendix 3.

Table 4. Impact assessment projects, the people in charge and the organizations that carried out the projects.

Project		Achievement	Person in charge	Organisation
D1	Effects of the weather-controlled traffic management system in the motorway between Kotka and Hamina	Report: Rämä, P. (1997). Effects of the weather-controlled traffic management system in the motorway between Kotka and Hamina, Finnra Report 1/1997	Yrjö Pilli-Sihvola	VTT
D2	Impact study of trial of enhanced weather monitoring system	Report: Malmivuo, M. ja Pajunen. K. (1998). The experiment of enhanced weather-monitoring system, Finnra Report. (outline)	Yrjö Pilli-Sihvola	VTT
D3	Mobile road surface condition monitoring	Report: Malmivuo, M. ja Pajunen. K. (1998). The experiment of enhanced weather-monitoring system, Finnra Report. (outline)	Jukka Savolainen	VTT Finnra
D4	The impact of variable speed limits on a single carriageway road	Report: Rämä, P. (1999). The impact of variable speed limits on a single carriageway road. Finnra Report. (outline)	Yrjö Pilli-Sihvola	VTT
D5	The socio-economic profitability of the Kotka-Hamina weather-controlled road	Report: Lähesmaa, J. (1997). The socio-economic profitability of the Kotka-Hamina weather-controlled road, Finnra Report 36/1997.	Mirja Noukka	VTT
D6	The impacts of variable road surface condition message signs on driver behavior	Report: Luoma, J., Rämä, P., Penttinen, M., Harjula, V. (1997). The impacts of variable road surface condition message signs on driver behavior, Finnra Report 22/2997.	Yrjö Pilli-Sihvola	VTT
D7	Bilingual variable message signs	Report: Harjula, V. (1998). Bilingual variable message signs – driver opinions and visual load. Finnra Report 1998. (outline)	Mikko Karhunen	VTT
D8	Effects of variable message signs on recall of fixed traffic signs	Report: Luoma, J., Harjula, V. ja Rämä, P. (1998). Effects of Variable Speed Limit Sign of Fiber Optic Technology on Information Overload.	Mikko Karhunen	VTT
D9	Study of the structure of RDS-TMC messages	Report: Luoma, J., Harjula, V. ja Penttinen, M. (1998). Development of comprehension of RDS-TMC messages. Finnra internal publications 20/1998.	Martin Johansson	VTT
D10	RDS-TMC - technical evaluation	The project has not been started yet	Martin Johansson	

3.5.2 Aims, main achievements and recommendations

D1) Effects of the weather-controlled traffic management system in the motorway between Kotka and Hamina

The aim of the study was to find out how speed limits and variable message signs that are controlled on the basis of road weather data affect driver behavior on the motorway and the drivers' opinions on the system. The functioning of the system and the reliability of this functioning were also examined. The study was carried out by interviewing drivers, by collecting data automatically with loop detectors, by monitoring randomly-selected vehicles with instrumented cars and by observing the weather, road surface conditions and road surface friction.

In the wintertime, the change in velocity from 100 to 80 km/h decreased the mean speed by 2.5 km/h (in addition to the average mean speed reduction of 6.3 km/h caused by adverse road surface conditions). In the summertime, the change in velocity from 120 to 100 km/h decreased the mean speed by 5 km/h. The standard deviation of the speed was also decreased. The speed limit was recalled well, as approximately 90% of the interviewed drivers recalled the speed limit correctly. The drivers (95%) also accepted the system and considered it to be necessary.

The impacts of variable speed limits have to be studied on other road types (semi-motorways, other dual carriageway roads) as well. The methods used to recognize slippery road surface conditions must be developed further.

D2) Impact study of trial of enhanced weather monitoring system

The aim of the study was to examine how the activities in Road Weather Monitoring Centers and Road TICs change after the implementation of the road weather monitoring system: the changes to the ways information obtained from the roads is used, the impacts of the enhanced road weather monitoring system on the management of maintenance operations and traffic information services, the uses of variable message signs and warning signs as well as variable speed limits, and the ways in which the enhanced road weather monitoring system improves the control of variable road surface condition message signs and speed limit signs.

The study included the interviewing of Road Weather Monitoring Center duty personnel, the monitoring of the actions of both Road Weather Monitoring Center and Road TIC duty personnel, the carrying out of friction measurements and the analysis of the command algorithms of variable speed limit and warning signs.

According to the study, Road Weather Monitoring Center duty personnel do not particularly take advantage of the enhanced network of road weather stations. The control of variable speed limits is not carried out in accordance with the original principles of the control system, in other words, taking local road surface conditions into consideration. Instead, the control of variable speed limits aims in practice at the variable speed limit signs of adjacent areas to show the same speed limit. However, the usability of the system was distinctly improved from winter 1996-1997 to winter 1997-1998

During the analysis of the sensor data collected by road weather stations, it was found that if a road weather station has several sensors, the view of the road surface condition will be more reliable than with the use of just one sensor, which is the number traditionally used. As the behavior of the sensors that produce the most important data for the command algorithm appeared to be quite unreliable, it is not possible to say whether the reliability of road weather monitoring is increased by the high number of road weather stations or just by the high number of sensors.

After the reliability of road weather stations has increased, the connection between local road surface conditions and the sensor data collected by road weather stations should be further examined. During the development of the automatic control of variable message signs, the information that road weather and traffic duty personnel are given on the algorithms to give them a better understanding of which sensor has caused the message on the sign to change, should be defined.

D3) Mobile road surface condition monitoring

The project concerning the impact assessment of mobile road surface condition monitoring was not started during the E18 programme. Instead, it will be started in the late winter of 1999.

The aim of the project is to find out whether mobile road surface condition monitoring is a viable solution for monitoring the road surface condition and the quality of winter maintenance operations. The viability of real-time friction data in the monitoring of the road surface condition and the quality of maintenance operations is of special interest.

D4) The impact of variable speed limits on a single carriageway road

The weather-controlled section of the motorway between Kotka and Hamina was extended in late 1997 to a semi-motorway and a single carriageway road. The aim of the study is to provide information on the impacts of variable speed limits and message signs on driver behavior on a single carriageway highway and to examine drivers' opinions on the system as well as how well the system has been accepted by road users. The reliability of the system was also examined.

Drivers were interviewed at the side of the road in February 1998. The variable message signs had two different messages: the 'caution' signal and the text message 'GUSTY WINDS' as well as the text message 'KEEP A SAFE DISTANCE' (the top half of the sign was empty).

Traffic information has been collected with loop detectors fitted onto the road, which record information on the speeds of individual vehicles and the distances between vehicles. This material is analyzed using a before-and-after comparison. Information on the weather and road surface condition has been collected not just at road weather stations, but also manually by the road maintenance station personnel.

The results of the interviews indicate that drivers had no problems in noticing the messages on variable message signs. The system is accepted, as was indicated by a prior study as well, and is also considered necessary. The study indicates that road users are somewhat less aware of the system's operating principles than before. Information services should therefore be developed to give the system some additional support.

The final results of the impacts of variable speed limits on driving speeds will be ready in June 1999, as stated in the research plan.

D5) <u>The socio-economic profitability of the Kotka-Hamina weather-controlled road</u>

The aim of the study was to examine the socio-economic profitability (benefit/cost ratio) of variable speed limits and message signs on the weather-controlled road between Kotka and Hamina.

Weather- and road weather-controlled variable speed limits are in use on the road section. During adverse weather or road surface conditions, when the accident risk is significantly higher than usual, the speed limit is lowered. The use of weather control decreases accident costs more (about 1.1 MFIM / a) than it increases time costs (less than 0.5 MFIM / a). Weather control has only a small impact on other driving costs.

The construction of a weather control system in 1994 cost 8.2 MFIM and its annual maintenance costs come to 300 000 FIM. The benefit/cost ratio of the project was calculated at 0.5. In other words, the obtained socio-economic benefits cover about half of all the costs.

At the moment, a similar system could be implemented at lower costs. The costs could also be further reduced by constructing the system on a longer road section, thus making the fixed costs of investments and maintenance relatively lower, and by trying out wireless data transfer. If variable speed limits and message signs could also be used for traffic situation-based traffic control, the investment would yield more benefits. Under these conditions, a road equipped with variable speed limits and message signs could be a socio-economically viable investment.

A similar research method could well continue to be used in the future to assess the economic viability of implemented systems containing variable speed limits. The development of the socio-economic profitability of the system can thus be monitored as the investment and operating costs change and the sign control criteria develop.

D6) <u>The impacts of variable road surface condition message sings on driver behavior</u>

Several message signs displaying information on the road surface condition have been introduced during the programme. The impacts of variable road surface condition message signs on the vehicle mean speeds have been studied. The signs may, however, also affect other driver behavior besides driving speed and the distance between vehicles. That is why the aim of this study was to examine the impacts of the variable 'slippery road' –signal and the variable 'keep a safe distance' –signal on the behavior of passenger car drivers.

The material was gathered by interviewing by telephone passenger car drivers who had passed the signs. The study showed that both signs had an impact on more than just speed and the distance between vehicles. The main impacts manifest themselves as a driver concentrates one's attentiveness on any indications of danger, checks the slipperiness of the road surface and acts more carefully while overtaking other cars.

On the other hand, the results indicated that the speed of a vehicle and the distance between cars are the main variables which the many other aforementioned factors have a positive correlation with. Impact assessments should therefore concentrate on the changes in vehicle speeds and driving distances.

D7) Bilingual variable message signs

In bilingual municipalities, texts on message signs must be in both of the official languages with the majority language on top. In Finland, variable message signs have, until now, been situated in municipalities with only one official language and their texts have only been in Finnish. Finnra's first trial with bilingual variable message signs began in December 1997 on the road between Sillankylä and Kotka (highway 7). The messages are displayed on the sign in Finnish and Swedish in turns. Each message is seen for two seconds at a time. The sign is empty for half a second between the messages. The study examined the opinions of drivers concerning bilingual variable message signs and studied the impacts of the message signs on visual load of the driver.

The results showed that the bilingual variable message sign, which displays the messages in turns, could be considered a viable solution. Most of the interviewed drivers considered the message display time suitable and the results on visual load indicated that the way the bilingual message was displayed had no significant effect on visual load of the drivers. Elderly drivers did, however, say more often than other drivers that they felt that the display time was too brief and that they looked at the bilingual message signs longer than young drivers did. As variable message signs demand more driver attentiveness than fixed traffic signs do, more attention should, during planning, be focused on the positioning of the signs, the messages displayed on the signs and the way these messages are displayed. It is also important to continue to study the impacts of variable message signs on the visual load of the drivers.

D8) Effects of variable message signs on recall of fixed warning signs

In the study the effects of a variable fiber-optic speed limit sign on perception of the fixed message sign in the vicinity were examined. According to the results, a fiber-optic speed limit sign in the vicinity of a fixed message sign had a significant negative effect on drivers noticing a fixed warning sign as opposed to a fixed speed limit sign. It is also worrying how few drivers noticed the standard warning sign. Based on the results, it is recommended not to place fixed message signs near the of fiber-optic variable message signs. The driver recall of fixed message signs should also be studied more extensively, as there is no information available on this subject from recent years.

D9) Study of the structure of RDS-TMC messages

As RDS-TMC was originally developed elsewhere in Europe, it was necessary to examine the structure of the most common messages used in RDS-TMC services as well as the clarity of the details of these messages in Finnish. The research material was put together through interviews.

According to the results, the message should first state the cause and then the effect. In traffic control information services, the consequences of traffic incidents do not have to be outlined.

The drivers' comprehension of the messages varied greatly. The interviewed drivers thought a 'long delay' meant a delay of 24-48 minutes, while a 'delay' meant a delay of 9-17 minutes. These durations were estimated to be about twice as long in the case of accidents as they were in the case of other incidents. The interviewed drivers had no problems comprehending e.g. the messages 'lane closed' or 'only one lane in use'. About one third of the interviewed drivers misinterpreted the expressions 'two lanes closed' or 'carriageway closed' associated with a motorway. Possible misinterpretations are factors that demand special attention.

D10) RDS-TMC - technical evaluation

There was no time to begin the technical evaluation of the RDS-TMC service during the E18 programme. A working plan is drawn up for the project at the turn of the year 1998/99. The aim of the project is to assess the characteristics of the RDS-TMC service, such as the validity and the comprehension of the information, the delay from the moment something happens to the moment the message is received, the clarity of the message and the quality of the communications network. The project will be carried out in 1999.

3.5.3 Summary

Main achievements

Weather- and road weather-controlled speed limits are accepted and understood. They also have a positive impact on traffic flow. A lower speed limit applied during adverse road surface conditions decreases mean speed and standard deviation of the traffic. Variable speed limits are also estimeted to improve traffic safety. However, under the current production costs and evaluating methods, the weather-controlled system on the road between Kotka and Hamina turned out not to be socio-economically viable.

Enhanced road weather monitoring gives a more accurate description of road surface conditions than traditional road weather monitoring systems do. Road weather duty personnel do not feel that they benefit much from the dense network of road weather stations.

Variable message signs are accepted by road users and remembered well, but they have a negative impact on driver recall of fixed traffic signs. Fiber-optic and fixed traffic signs should not be used close to one another.

Bilingual variable message signs do not create any more visual load than two signs situated one after another. Most drivers considered the used message display time to be suitable. Bilingual variable message signs do, however, increase the visual load, especially as regards elderly drivers, in comparison with monolingual variable message signs.

Road surface condition message signs have a positive impact on many factors associated with safety, such as attentiveness, the checking of road slipperiness and overtaking behavior. The study gave additional support to the decision to use road surface condition message signs as one standard solution that can be used at sites, which often suffer from adverse road surface conditions.

RDS-TMC messages should first present the cause and then the effect. The abilities of road users to comprehend messages vary greatly.

Recommended follow-up projects

These recommended follow-up projects are a direct continuation of the projects included in the E18 programme. The following transport telematics development projects and impact assessments are, according to the impact assessments carried out on the E18 test area, among the most important tasks for the future:

- the further development of road weather monitoring systems which control variable speed limits
- the drawing-up of consistent operating principles for variable message signs for a continuous road section e.g. Turku-Helsinki-Vaalimaa
- further study of the visual load caused by variable message signs, e.g. closer examination of the visual load of elderly drivers
- the examination of the possibility of tests on bilingual message signs in Finnish and Russian
- the use of variable road surface condition warning signs as a standard solution at sites which experience problems often, in accordance with the principles laid out in the report "Guidelines for experiments and use of variable message signs at Finnra" (Finnra 1996).

Other impact assessments

The impacts of transport telematics have been examined in several studies, which are not part of the E18 programme. Views towards the utilization of transport telematics have probably been influenced the most by the study conducted by Kulmala and Pajunen (1986) on the use of variable speed limits at the Korso junction on the Tuusulantie-road, the study on the impacts of the variable route direction system on highway 4 between Järvenpää and Mäntsälä (Alppivuori et al. 1995), the study on the impacts of the variable traffic control system at the Kallansillat-bridges (Savo-Karjala Region 1995), the study on the impacts of variable speed limits in the Keski-Suomi Region (Finnra 1995b), the study on the information requirements of car drivers (Penttinen 1996) and the studies on the impacts of automatic traffic monitoring on driver behavior on highway 1 (Mäkinen and Rathmayer 1994) and at traffic signal-controlled junctions (Anila and Mäkinen 1998).

Main impact assessments in the future

The most important impact assessments that should be carried out in the near future to best support the development of transport telematics as a whole are:

- an outline of the optimal level of traffic monitoring, i.e. the extent to which traffic should be monitored in different ways in order to collect enough information for traffic information services and traffic control
- the impacts of traffic situation-controlled variable speed limits
- the impacts of traffic information services and the viability of user interfaces of the media
- study of the combined impacts of various transport telematics services and the impacts that the different services have on one another
- the development of methods for use in impact assessments and project comparisons
- the impacts of information services and traffic control on foreign drivers
- the impacts of driver support systems, such as lane keeping support, collision prevention or improved visibility.

4 FINNISH TRANSPORT TELEMATICS SOLUTION

4.1 In general

The Finnish transport telematics solution is the current view of how data collection and processing as well as traffic control and information services should be set up, and what kinds of equipment or methods are available. Some methods associated with transport telematics cannot, however, be utilized yet.

Chapter 4 first examines the development that has taken place in the field of transport telematics during the E18 programme. After this, the aims of transport telematics and the methods that can be used to achieve those goals are defined.

During the programme it became apparent that it is not possible to define a single system as the best for Finnish conditions. The traffic conditions on different types of roads in different parts of the country are very different from one another. Hence, the Finnish transport telematics solution has been defined for a variety of different environments: inter-urban motorways, two-lane roads with a high traffic volume, two-lane roads with a low traffic volume, the main highways in urban areas and individual sites.

The solution has been described in each road category according to the same structure: the aims of transport telematics, the means available to reach these goals, and the methods used to monitor traffic conditions. All categories use the same methods of data analysis, which can be found in paragraph, 4.4. The special characteristics of the Finnish transport telematics solution are examined in paragraph 4.5.

The definitions of the systems for the individual road categories utilize not only the results of projects included in the E18 programme, but also Finnra's traffic management strategy (Finnra 1998) and the results of the study on transport telematics systems carried out at the Kaakkois-Suomi Region (Lähesmaa et al. 1998).

4.2 Development of transport telematics

During the E18 programme, the utilization of transport telematics has moved on from the development of individual services and systems to the phase in which an attempt is made to compile information collected from different resources into a single service database. A uniform traffic control user interface is developed for the service database for the feeding and presenting of the information. During the attempt at system integration, the importance of the definitions of the planned systems and the associated operations within the system architecture has been noted. As the operational environment is changing constantly, the systems have to be implemented in stages and the implementation has to be prepared for possible changes in the needs of users and rapid changes that may have to be made to the system.

The information obtained through road weather stations and automatic traffic measurement points has been adapted for serving real-time traffic information services and traffic control. Just a while ago, they were still mainly used in winter maintenance operations and transport system planning. On the other hand, it has been noted that these fixed stations do not provide an extensive enough view of the traffic conditions. Video cameras have been utilized to complement the information obtained through the stations in both road weather and traffic situation monitoring. Road weather monitoring with moving vehicles is also currently under development.

The original objectives of the programme were least successfully fulfilled in the information management –area. One reason for this lack of success has been the outsourcing of data processing operations at Finnra, which has disturbed the long-term development of the system. Not enough experts in information technology and systems planning were available to work on the projects in the information management –area. The definition of the service database was also the most extensive and, by its foundations, the most disorganized task included in the programme. This extensive definition was done during the programme. The traffic management user interface for processing data on road works was implemented first.

Projects included in the programme have developed modelling methods for processing collected information, allowing the more precise and reliable carrying out of traffic control and information services. The development of the modelling methods, which utilize road weather data, has gotten the farthest during the E18 programme. These methods can now be tried out in practice. The programme also taught that it is important to use modelling in the future in developing traffic forecasts for next few hours.

The utilization of variable speed limits in traffic control has developed and become more extensive. Weather- and road weather-controlled variable speed limits can be used to influence driver behavior and driving speeds. Hence, weather- and road weather-controlled variable speed limits are expected to increase traffic safety. In addition to this, road users consider variable speed limits to be good service. Roadside information signs support the use of variable speed limits by providing additional information and describing the reason that a lower speed limit is being used at a certain time. The individual impact information signs have on driving speeds, when used along with variable speed limits, is small.

In the field of information services, service chains with which the information about traffic and weather will be transmitted through different distribution channels to the road users have been especially developed. This has increased the amount and improved the quality of the information Finnra provides for radio and television. The principles concerning the type of information provided and the time this information is provided have been defined more clearly. The way information kiosks are constructed has been defined, and services, which correspond with the new solution, have been tried out. A new Internet-service for motorists has been introduced. There have been trial runs of RDS-TMC and GSM services. The services that were tested during the E18 programme have been found to be of use, and the provision of information to producers of value added services has also been found to correspond with Finnra's objectives. The users of information services appreciate these services and feel they are willing to change the timing of a trip and their driving behavior on the basis of the information provided (Penttinen 1996).

Winter maintenance operations have become more efficient as the weather and road surface condition can be monitored with greater accuracy and the maintenance operations can be carried out when needed. The work of road weather duty personnel has especially been made easier by the growing number of road weather cameras and the fact that road weather camera images from the various road regions can be accessed by the public. Maintenance operations can be started at the right time and in the correct scale. The system, which allows the monitoring of the movements and actions of the maintenance fleet at Road Weather Monitoring Centers, supports fleet management. Road users can also be given information on the current status of maintenance operations. The management of maintenance operations is an important target for the utilization of transport telematics in all road environments.

4.3 Use of transport telematics in different road environments

4.3.1 Inter-urban motorways

The use of transport telematics on inter-urban motorways aims at

- increasing traffic safety
- using a travel speed which is suitable for the road conditions
- minimizing the impact of exceptional incident situations.

The methods used are

- information prior to the trip

  Information is given on long-term or predictable situations which may impede traffic, the cause and duration of these situations, as well as the weather and road surface condition, allowing road users to change the timing or route of their trip or to be prepared for the situation in some other way. The media used include the Internet, telephone, radio, television, teletext and newspapers. Radio and television are used especially when giving out information on sudden, surprising incident situations.

- information during the trip

  Information is given on the cause and duration of incident situations or increasing congestion as well as the weather and road surface condition. The information is transmitted through regional radio broadcasts, RDS, RDS-TMC, other vehicle terminals or mobile communicators and roadside information signs. High-quality service and rest areas also have information kiosks, which also provide drivers with information on route alternatives and local services.

- variable speed limits and message signs

  Variable speed limits are used on motorways when needed. The speed limit is changed according to the prevailing traffic situation as well as the weather and road surface condition. Information signs can be used along with variable speed limits to give road users additional information on road conditions or the reason for the current speed limits.

- route direction.

  Road users can be directed to use an alternative route or detour, if necessary.

Traffic, weather and road weather monitoring require a system, which provides Road TICs with *real-time* data, including

- a network of road weather stations and cameras, as well as mobile road weather monitoring
- a dense network of road weather stations on roads which use variable speed limits
- weather forecasts from the Finnish Meteorological Institute or other forecast providers
- information provided by contractors on maintenance actions and road works
- a sparse network of traffic monitoring stations
- co-operation with the police and rescue services, especially concerning the provision of information on traffic incidents
- reports on incident situations, made by private motorists, which can be used to complement the official records.

4.3.2 Two-lane roads with high traffic volume

Transport telematics is used on two-lane roads with high traffic volumes to try to

- increase traffic safety
- increase traffic efficiency
- increase travel time predictability
- make driving speeds more consistent and increase the road capacity
- even out traffic demand deviation
- minimize the impact of exceptional incident situations

The methods used are

- information prior to the trip

  Road users are given information on long-term and predictable situations which impede traffic, such as sudden incident situations, road works, the status of maintenance operations as well as the weather and road surface condition in order to allow drivers to alter their plans or be prepared for delays. The most important media used include the radio and TV, teletext, the Internet and newspapers.

- information during the trip

  Road users are given information on situations which impede traffic e.g. by causing queues or congestion, so that road users could decide on using an alternative route in good time or could behave on the road in a way that is suitable for the situation. Information is also given on the weather, road surface condition and status of maintenance operations. The main media used are the radio, RDS, RDS-TMC and information kiosks.

- variable speed limits and message signs

Two-lane roads, which have problems with traffic fluency due to the high traffic volume, can utilize traffic situation-, weather- and road weather-controlled speed limit signs. Information signs can be used along with variable speed limits to give road users additional information on road conditions or the reason for the current speed limits.

Traffic, weather and road weather monitoring require a system, which provides traffic management centers with *real-time* data, including

- a network of traffic monitoring stations and road weather stations. Some of these stations also have combined traffic and road weather cameras
- mobile road weather monitoring
- a dense network of traffic monitoring stations and road weather stations on roads which use variable speed limits
- weather forecasts from the Finnish Meteorological Institute or other forecast providers
- information provided by contractors on maintenance actions and road works
- co-operation with the police and rescue services, especially concerning the provision of incident data
- reports on incident situations, made by private motorists, which can be used to complement the official records.

4.3.3 Two-lane roads with low traffic volume

Transport telematics is used on two-lane roads with low traffic volumes to try to

- increase traffic safety
- minimize the impact of exceptional incident situations.

The methods used are

- information prior to the trip

  Road users are given information primarily on road works, the weather and road surface condition and the status of maintenance operations. The information is transmitted via teletext, the Internet, regional and local radio stations and newspapers.

- information during the trip.

  Information is primarily given on the weather and road surface condition, but it is also important to provide information on the status of local maintenance operations. Information is given on traffic incidents, such as accidents, if and when information comes in. The information is transmitted via national, regional and local radio stations, RDS and RDS-TMC, other vehicle terminals and mobile communicators.

Traffic, weather and road weather monitoring utilize

- mobile road weather monitoring
- a sparse network of road weather stations and cameras
- information provided by contractors on maintenance actions and road works
- co-operation with the police and rescue services, especially concerning the provision of incident data

- reports on incident situations, made by private motorists, which can be used to complement the official records.

4.3.4 Main highways in urban areas

Transport telematics is used on the main highways in urban areas to try to

- make driving speeds more consistent and increase the road capacity
- minimize the impact of exceptional incident situations
- increase traffic efficiency
- increase travel time predictability
- even out traffic demand deviation
- increase traffic safety
- decrease environmental hazards

The methods used are

- information prior to the trip

  Information is given on long-term or predictable situations which may impede traffic, the cause and duration of these situations, as well as the weather and road surface condition, allowing road users to change the timing or route of their trip or to be prepared for the situation in some other way. The information is transmitted via the Internet, the phone, radio, television and newspapers. Information on sudden, surprising exceptional situations is also given by radio and on television, media which reach a large number of motorists quickly. The use of public transport is recommended in the case of long-term incident situations.

- information during the trip

  Information is provided on the real-time congestion situation, congestion that is just forming, the reasons for the congestion, and the weather and road surface condition. The information is transmitted during regional and local radio broadcasts, and via RDS, RDS-TMC, other vehicle terminals and mobile communicators.

- variable speed limits and message signs

  Variable speed limits are used to make the speed limits on the main arterials of big cities suitable for the prevailing traffic situation and road surface conditions. Variable message signs used in route guidance instruct drivers to choose the best alternative route in light of the actual traffic situation. A system with changing lane directions will be implemented if necessary.

- control of traffic signals

  Traffic signals are controlled taking into consideration the needs of and the current situation on the entire regional road system.

- demand management.

Control of vehicle merging is used, if necessary, to prevent the build-up of congestion on the main arterials with the most heavy traffic. The implementation of road pricing systems is monitored so that these systems can be introduced, when needed, to control traffic demand in light of environmental issues or in order to control the timing of the use of the road capacity.

The monitoring of traffic and road weather conditions demands an extensive system for providing real-time data for Road TICs, which includes

- a traffic monitoring system
  The system monitors traffic flow. The automatic monitoring system is also used to detect exceptional situations in real time on road sections, which have recurring problems with traffic efficiency. The monitoring system is made up of a combination of automatic traffic monitoring stations and video surveillance points. In the future, it may be possible to monitor the traffic situation on the basis of information collected by sensor vehicles.

- a weather and road weather monitoring system
  The system extensively monitors the prevailing road conditions with road weather stations and cameras.
  The Finnish Meteorological Institute and other forecast providers provide weather forecasts.

- co-operation between the police, rescue services, municipalities and Finnra.
  A co-operative system of information exchange gives Road TICs information the police and rescue services have on traffic incidents such as accidents, incident duration and unusual traffic arrangements during incident situations. Cities provide information on the current traffic arrangements on the street network, which may also affect traffic on public roads. Contractors provide information on maintenance operations and road works.

4.3.5 Individual sites

Individual sites in which transport telematics can be used are e.g. bridges and tunnels, sites that often experience adverse traffic or road surface conditions, elk crossings and dangerous junctions with heavy traffic.

The objectives are, depending on the site, to
- increase traffic safety
- increase traffic efficiency
- decrease environmental hazards
- minimize the incidents and danger situations caused by exceptional situations
- serve road users.

Variable speed limits can be utilized at dangerous junctions or junctions with heavy traffic to decrease the vehicle mean speeds on the main road, thus making merging easier and increasing traffic safety. Dangerous or easily congested junctions can also be outfitted with traffic signals. Automatic camera monitoring can be used at junctions where accidents are caused by speeding and traffic signal violations. Only one study has ever been carried out in Finland on the impacts of variable speed limits at junctions (Kulmala and Pajunen 1986). In this study, variable speed limits were found to increase traffic safety, but not to increase traffic efficiency at the junction. However, it has later been assessed that variable speed limits can also make merging easier (Lähesmaa, Schirokoff and Portaankorva 1998). In the study by Anila and Mäkinen (1998), monitoring at traffic signals was found not to decrease the number of traffic signal violations. This can mainly be explained by the fact that red light running also decreased in the control areas. Camera surveillance decreased driving speeds a great deal, permanently and consistently.

Variable speed limits and lane control systems can be utilized on bridges and in tunnels. An attempt is made to get the driving speeds to suit the road conditions. In exceptional situations, traffic can be guided as smoothly as possible over a bridge or through a tunnel. The flow of traffic can also be stopped if necessary. Traffic monitoring calls for an extensive network of automatic traffic monitoring stations and video surveillance. The monitoring of foreseen exceptional situations has especially benefited from the co-operation between the authorities and contractors. Road weather stations and cameras monitor the weather and road surface condition. In the impact assessment of the variable traffic control system at the Kallansillat-bridges (Savo-Karjala Region 1996), the system was found to have increased traffic fluency and working safety during exceptional traffic control situations. Variable speed limits have been adhered to, and they have decreased the traffic mean speed. Vehicles move onto the desired lane earlier than before, and lanes that have been marked closed with red cross displays have not been used.

'Slippery road' warnings are displayed on variable message signs at sites, which often experience adverse road surface conditions. Longer road sections with adverse road surface conditions also have variable speed limits. The weather and road surface condition are monitored at road weather stations and with road weather cameras and with the help of forecasts obtained through the Finnish Meteorological Institute and other parties. Rämä et al (1996) showed that a variable 'slippery road' sign decreased vehicle mean speeds by about 1-2 km/h. Luoma et al (1997) used an interview survey to show that variable road surface condition message signs have many positive impacts on driver behavior. Variable road surface condition message signs are thus believed to improve traffic safety.

Variable elk warning signs can be used to warn drivers of elks moving close to openings in Game fences. Elk surveillance is carried out with roadside elk radars, which detect any movement in the roadside. The impacts of variable elk warning signs have been examined on the Porvoo motorway (E18) (Muurinen and Ristola 1998). The findings of this study are surprising, perhaps due to the deficiencies the project had in the field of data collection. Elk warning signs were found overall to increase the vehicle mean speed, but during adverse road surface conditions, the mean speed decreased when elk warning signs were used. Only one of the 107 situations seen on video concerning elk warning signs was found to be caused by elk movement. The effects of the variable elk warning system will be examined at the Kaakkois-Suomi Region in 1999.

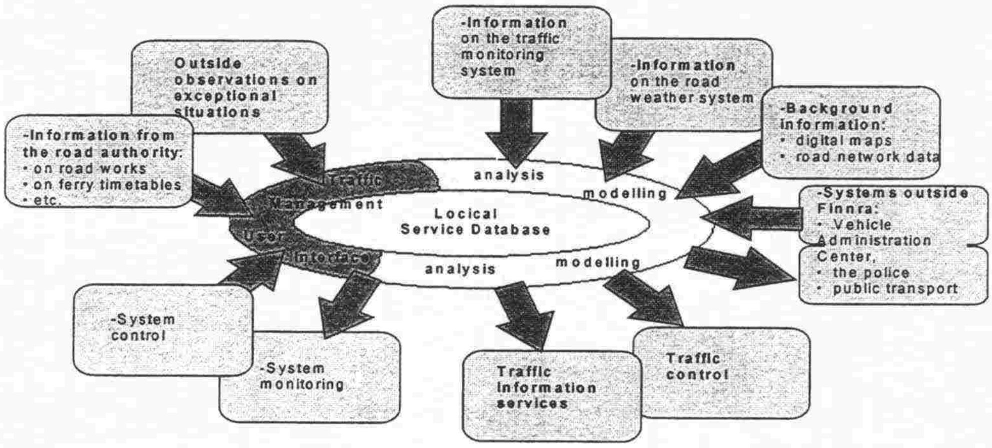
4.4 Methods and systems used in information management

Traffic management includes the compiling of the necessary information from other systems into Finnra's traffic management service database, which is a decentralized data system made up of a number of inter-system descriptions and guidelines. In the service database, monitoring data is analyzed into a form that can be used as the basis for the distribution of messages concerning traffic control and information services to various systems. Figure 1 presents the operating principle for the service database.

The information required for traffic management is updated automatically through the road weather system and traffic monitoring system into the service database. Information from other Finnra systems can also be accessed via the service database. Information obtained from external, e.g. police or municipal, data systems is also automatically recorded into the service database. Traffic Management Center duty personnel can access and alter the information in the service database and monitor the functioning of the system e.g. through the traffic management user interface. If necessary, they can manually input messages used in traffic information services or control variable message signs. This manually uploadable information includes information on exceptional situations that is transmitted to the center by phone, data from road weather and traffic surveillance cameras or information on road works.

Figure 1. The operating principle of the traffic management service database

The information in the service database is used when making decisions on the type of information that is broadcast in the various media and the way traffic is controlled. Information management, information services and traffic control are carried out mostly automatically. The service database uses models to describe the methods used in traffic information services or traffic control. Any new information obtained through the monitoring system is analyzed and placed in the model. The system alters the information in the media or sends out a bulletin on the basis of the guidelines contained in the models, while new information can automatically cause certain steps to be taken in traffic control. One example of this is a situation where information is obtained from a road weather station saying that it started to rain and that the road surface temperature is below zero. With the use of a model that analyzes the information sent by the road weather station, the system may e.g. come to the conclusion that it should send the 'slippery road' RDS-TMC message to the area, while the variable speed limit signs should display a speed limit of 60 km/h. The system is controlled and supervised by man.



4.5 Finnish special characteristics

The way transport telematics are applied in Finland is especially influenced by the following special characteristics of the country: the great effect the weather and road surface conditions have on traffic, the large number of roads with low traffic volumes, sparse population and long distances.

The weather and road surface condition have to be taken into consideration in the control of message signs and in traffic information services. Hence, information on the road weather also has to be collected and processed efficiently. Finland is a forerunner in weather- and road weather-based traffic control and information services.

When one wants to increase safety and traffic efficiency on roads with low traffic volumes as well, one should be able to collect information on factors affecting traffic, especially incident situations, without an expensive network of traffic monitoring stations. The absence of such a network accentuates the need for mobile traffic and road weather monitoring as well as case-by-case reports on incident situations from the authorities and road users. Roads with low traffic volumes also cannot support extensive systems of variable message signs. Instead, the information affecting traffic has to be transmitted through the media or to in-vehicle equipment during the trip. This is made possible by Finland's highly developed communications infrastructure and by preparedness of the citizens to utilize new technology.

In Finland in sparsely populated areas using private car is almost unavoidable, as it is difficult to run a profitable public transport system in these areas. As some of the trip therefore has to be traveled with a private car, driver information services should also outline the possibility of travelling part of the journey using public transport (park-and-ride), thus increasing traffic safety and decreasing environmental hazards. The use of public transport also reduces congestion mostly in the vicinity of big cities and on certain main roads.

5 SELF-EVALUATION OF PROJECT IMPLEMENTATION

5.1 In general

The chapter on the self-evaluation of the project implementation contains a compilation of the estimates of the members of the E18 programme's programme group on the pros and cons of the programme and the success of programme management and organisation. The programme's success in the field of information transfer and whether the programme included a sufficient amount or too much risk have also been assessed. The actual objective post-evaluation of the programme will be carried out later by an outside party.

5.2 Pros and cons of programme

Compiling all of the projects into one programme turned out to be useful. The trials could be concentrated on the same road, and the programme assisted the management and distribution of the information obtained during the projects. The co-operation between the road regions and central administration was a very important point. The solutions pointed in the same direction, and the same trials did not have to be carried out in all of the road regions. The fact that the projects belonged to the same programme made it easier to control the projects as a whole: projects e.g. did not concentrate on developing a particular tool used to collect information while forgetting the actual use of the information. When the projects were handled together, it was easier to form a picture of the over-all results of the use of transport telematics and to compare the viability of different solutions. The projects thus became more target-oriented.

The fact that the projects belonged to a single programme promoted the spread of uniform solutions at Finnra. The road regions implement the best solutions on the basis of previous experience and use the same technology. This increases system interoperability and decreases the implementation costs of future systems.

The programme contained a mechanism, which was used to collect information on the projects and to deliver it systematically. The information was thus spread quickly to a large number of interested parties. If it were not for the E18 programme, the projects would have had to invest more on arranging the provision of information services, or the people following the projects would have had to obtain the information by themselves. Thanks to the programme, the projects were more visible in Finland, and the E18 road became known even abroad as the telematics test area. It would have been difficult and costly for an individual project to obtain such visibility. Belonging to the E18 programme also increased the esteem of the individual projects.

Receiving funding was easier for projects included in the programme than for independent projects. If it were not for the weight lent by the programme, the individual telematics projects could have been lost among the dozens of other

Finnra projects. The individual road regions were also able to obtain more resources than usual for the projects.

Compiling the projects into a single programme had virtually no disadvantages. The most significant problem was the fact that the E18 programme caused some problems between road regions that were involved in the programme and those that were not. Road regions outside the E18 road would have also wanted to be more involved in the testing of telematics solutions and the development of regional operations.

5.3 Programme management and organisation

The cooperation between the programme coordinator, project secretary and programme group went well. The responsibilities of the different parties were clearly defined, and all parties fulfilled their obligations well. The programme coordinator and programme group did not, however, have executive power as regards the most important matters concerning the programme. The programme coordinator of the E18 programme could not directly influence the decisions made concerning the projects or the obtaining of information on the projects. In some cases, this resulted in projects that were essential for the whole of the programme not being developed the way the programme group would have wanted.

The traffic management steering group did not function very actively as steering group. The programme was the responsibility of the programme group and the programme coordinator and his assistants. The reason for this was apparently the fact that the projects included in the programme were in no way connected with the daily tasks of the members of the steering group, and the members of the group therefore had no time to discuss the status of the projects in detail.

The programme coordinator having no executive power and the lack of support from the steering group were especially visible when organizational changes were carried out at Finnra. The outsourcing of data processing services hindered and slowed down the development of information management systems. The programme coordinator could not amend the situation, and the consequences of the arrangements were not clear enough for the steering group for them to amend the situation quickly.

5.4 Success of communication

The programme group and steering group were well informed on the status of the programme. The people in charge of the projects who were not members of the programme group were also sufficiently kept up to date of things. The people actually carrying out the projects, however, were not given enough information on the programme as a whole.

The memos on programme group meetings and the project monitoring tables and project monitoring report were informative and were drawn up regularly. So much information was, however, provided, and in such a condensed form, that analyzing it all caused some problems for people who did not constantly keep up with the programme. The four-month period in late 1997, when there was no active project secretary, made keeping up to date of and providing information on the projects more difficult.

The information on the programme to outside parties was reasonably successful. The programme and the individual projects were presented at several international and Finnish events. Industry maybe should have been briefed on the test area more clearly. More industry-related trials would have been desired for the test area. As things stand, the people in charge of the programme were not completely successful in their attempt to get industry involved in the programme, and the development projects mostly originated at Finnra.

More time and resources should have been put into information services. Project pamphlets could have been published regularly and more often than once a year, which was the average publication frequency during the E18 programme. Intermediate seminars meant for outside parties would also have been profitable.

5.5 Risk taking

Sufficient risk taking is the sign of a good research and product development programme. The E18 programme included appropriate amount of risk taking. New ideas, such as the construction of a probe vehicle for friction monitoring, enhanced road weather monitoring and the development of methods used in road surface condition recognition, were tried out with no guarantee of success.

Good results were obtained by taking risks. The trial on mobile road surface condition monitoring has yielded some promising results. The system can expand and significantly increase the amount of information obtained on road surface conditions. The methods used to recognize road surface conditions improve the quality of road weather data as well as the quality of traffic control and information services.

On the other hand, some of the original goals were not achieved. The utilization of enhanced road weather monitoring has experienced technical difficulties, and the development of the service database has been slower than expected. None of the projects failed completely.

6 FOLLOW-UP ACTIONS

6.1 Most important tasks for the coming years

The following is an outline of the most important tasks involving R & D projects of transport telematics at Finnra. The follow-up actions and main recommendations given to individual projects in the E18 programme according to programme area (data collection, information management, distribution of data, and impacts) are discussed in chapter 3. The definition of the most important future tasks utilized the results of the "Development of transport telematics" survey sent to the road regions and Finnra's central administration. E18 programme's programme group defined the most important future tasks on the basis of the results of the survey.

- The collection of weather and road weather data will be developed by increasing the reliability and comprehension of road weather and road weather camera systems and by producing a mobile road surface condition monitoring solution suitable for use in the production of services. In the collecting of traffic data the most important tasks are the utilization of automatic traffic measurement points, the developing of traffic camera image recognition and the obtaining of information on traffic incident situations from the police, rescue services and road users.
- The development targets associated with modelling include both road surface condition and traffic models. The models should be used in adapting the information obtained through a variety of different sources into a form that can be more easily used e.g. in traffic control and information services. The main targets for modelling include road surface recognition and classification and traffic models for predicting travel times.
- The traffic management service database will be created and its' information contents will be defined and the implementation will be started. The various sections of the service database will be developed and constructed phase-by-phase, starting with the most important sections: the incident database and the Road Traffic Information Center log.
- Variable speed limits will be tried out on different types of roads and in different traffic conditions, and their operating principles will be developed. Systems of variable speed limits will try out different technical solutions. The impacts of variable speed limits on driver behavior will be examined in different situations and when using different operating principles. Suitable locations for the use of variable speed limits will be determined on the basis of the impact assessment. The use of variable speed limits may also be expanded. VMS-based traffic control will be developed with the help of trials, and the impacts of these trials will be assessed.
- Media and information services corresponding with Finnra's role, the situations in which the various media are used and the transmitted information will be defined. Detailed information on the information requirements of road users will be needed for the description. The impacts of these information services e.g. on driver behavior and safety will be examined, and if the im-

pacts turn out to be positive, the use of information services will be increased and supported. Since the quality of the entire service chain is only as high as the quality of the weakest link of the chain, the functioning of the chain is tested periodically. Finnra's relations with the producers of value added services will also be defined.

- The management system for winter maintenance operations will be developed. The information contained within the road weather system will be developed into an illustrative form, which supports decision making on maintenance operations. The maintenance fleet monitoring system will be expanded, and the transmission of information on current maintenance operations from vehicles to the Road Weather Monitoring Center will be automated.
- The development of intelligent speed control systems for vehicles will be monitored, and if necessary, participated in. The role of the road authority in the development of in-vehicle equipment and the impacts of this equipment on safety will be examined.
- The development of demand management abroad will be monitored during the next few years. The aim is to discover possible methods for use in demand management and the necessity of the use as well as the impacts of the methods in Finland.
- New methods are needed for assessing the impacts and possible uses of transport telematics. Guidelines are needed for assessing the impacts of traffic information services on driver behavior and safety. Operating principles will be developed for assessing the feasibility of transport telematics projects. Methods, which also take other impacts besides economic ones into consideration, will also be developed for project comparisons.
- The viability, user experiences and impacts of existing systems will be monitored. Information on user experiences will be spread in order for a large amount of people to learn from the pilot projects, thus promoting the introduction of functioning, economically feasible systems. Sufficient resources should be allocated to maintenance and to securing the functioning of the system.

6.2 Current programmes and their significance

The European Union´s VIKING project coordinates the research and development and the implementation of national and Northern European traffic management and telematics systems. In Finland, the VIKING project includes a large amount of Finnra's R & D projects, and is a good channel for Finnra's internal project information transfer. However, the VIKING project by itself does not offer a sufficient mechanism for controlling and coordinating Finnra's transport telematics R & D operations. If the support given by the VIKING project for the R & D projects carried out by Finnra's central administration and all of the Regions were to be removed during the next couple of years, another channel would be required for exchanging information on experiences.

Finnra's R & D projects should be incorporated, where appropriate, to the Finnish Ministry of Transport and Communications' Finnish National R & D Programme on ITS Infrastructure, TETRA, and the European Union´s fifth framework programme. Many developmental targets that are close to Finnra's operations, such as the development of monitoring systems of traffic and environmental conditions and traffic management systems, are core projects in the TETRA programme. The TETRA programme especially increases co-operation and data exchange between the various parties associated with traffic systems. It is worthwhile to try to get funding from the fifth framework programme for tasks that would be carried out anyway. Being involved in EU projects also provides international contacts as well as information on the work being done in other countries.

Transport telematics should be kept an independent theme within Finnra's R & D programme. As an independent theme, transport telematics and the individual projects will be more visible among the other targets for R & D operations at Finnra.

6.3 Organising transport telematics R & D operations at Finnra

Both the road region and Finnra's central administration have knowledge of transport telematics, so the initiative and work of both parties are needed. However, development operations should be carried out in a controlled fashion, with the solution of traffic problems and user requirements both working as the basis of the development. Finnish experts, who are aware of the requirements and who can take care of the implementation, should be included in the realization of R & D operations.

As the focus of the VIKING project shifts to implementation projects, a new mechanism will be needed to ensure the provision of information on R & D projects. A group may also be needed to agree on the controlled implementation of R & D projects. The traffic management steering group might function as such a group, if there is a desire to expand the job description of the steering group. A new group could also be formed for the task.

The task of the group is to stay abreast of the need and plans for developmental projects and to agree on the implementation of projects at the road regions and at Finnra's central administration. When agreeing on the starting of projects, the task of the group is to make sure that the operations included in different projects do not overlap, and that the trial projects will take Finnra policy into consideration. The group will also make sure that the impacts of and experiences gathered during the projects will be assessed and reported in a mutually beneficial way.

The group can be made up of the regional heads of traffic services, representatives of the Traffic Services -unit at Finnra's central administration and the people in charge of traffic control and information processes. The structure of the group would then correspond with the structure of Finnra's current organisation and processes concerning the creation and implementation of R & D projects of transport telematics. The group requires a secretary to be in charge of updating project data and providing information on the projects. The operations of the group and the projects can also be organized into a Finnra-wide transport telematics' R & D programme.

REFERENCES

Alppivuori, K., Anila, M. ja Pajunen, K. 1995. Valtatie 4:n Järvenpää–Mäntsälä-välin muuttuvan reittiopastusjärjestelmän vaikutukset. Tielaitoksen selvityksiä 86/1995. Tielaitos, Kehittämiskeskus. Helsinki 1995. 55 s. + liitt. 19 s.

Anila M. ja Mäkinen T. 1998. Automaattisen liittymävalvonnan vaikutukset kuljettajien käyttäytymiseen valo-ohjatuissa liittymissä – Loppuraportti. VTT-yhdyskuntatekniikka. Tutkimusraportti 443. Espoo, 1998.

Kulmala R. ja Pajunen K. 1986. Konfliktitutkimus Tuusulantien Korson liittymässä. Valtion teknillinen tutkimuskeskus, Tiedotteita 641. VTT Offsetpaino, Espoo. 44 s. + liitt.

Lähesmaa, J., Schirokoff, A. ja Portaankorva, P. 1998. Kaakkois-Suomen tiepiirin telematiikkaselvitys. Tielaitoksen selvityksiä 42/1998. Kaakkois-Suomen tiepiiri. Kouvola 1998. 98 s. + liitt.

Muurinen, I. ja Ristola, T. 1998. Elk accidents can be reduced by using transport telematics. Proceedings of the 5th World Congress on ITS. Seoul, October 12-16, 1998.

Mäkinen, T., Rathmayer, R., 1994. Automaattisen nopeusvalvonnan kokeilu – Loppuraportti. Sisäasiainministeriö. Poliisiosaston julkaisu 13/1994. Helsinki, 1994.

Penttinen, M. 1996. Autonkuljettajien informaatiotarpeet. Tielaitoksen selvityksiä 73/1996. Helsinki 1996.

Rämä P., Kulmala, R. ja Heinonen, M. 1996. Muuttuvien kelivaroitusmerkkien vaikutus ajonopeuksiin, aikaväleihin ja kuljettajien käsityksiin. Tielaitoksen selvityksiä. 1/1996. Helsinki 1996.

Savo-Karjalan tiepiiri 1995. Kallansiltojen muuttuvan liikenteenohjauksen vaikutusselvitys. Tielaitoksen selvityksiä. Savo-Karjalan tiepiiri. Kuopio 1995. 36 s.

Tielaitos 1995a. Tieliikenteen telematiikka, sen vaikutukset ja vaikutusten arviointi. Tielaitoksen selvityksiä 12/1995. Tielaitos, keskushallinto. Helsinki. 99 s.

Tielaitos 1995b. Muuttuvat nopeusrajoitukset Keski-Suomen tiepiirissä. Tienkäyttäjähaastattelu. Tielaitoksen sisäisiä julkaisuja 64/1995. Keski-Suomen tiepiiri. Tampere 1995. 13 s.

Tielaitos 1996. Muuttuvien opasteiden kokeilun ja käytön toimintalinjat Tielaitoksessa. Tielaitos, Keskushallinto. Helsinki 1996. 13 s.

Tielaitos 1998. Tielaitoksen liikenteen hallinnan strategia. Tiehallinto. Tie- ja liikenneolojen suunnittelu. Helsinki 1998. 39 s.

Kirjanmerkki "Viim_sivu" Älä hävitä, muunna valkeaksi, mutta vasta ihan viimeksi!!

Transport telematics – E18 test area

Project pamphlet no. 1, October 1996

Aims of the programme

Finnra's aim was to increase traffic efficiency and safety and to improve travelling comfort by utilizing new technology. Telematic solutions in the fields of traffic control, information services and enhanced winter maintenance of the road network are tested and evaluated on the TERN-road E18 from Turku to Helsinki and on to Vaalimaa. The aim is to formulate principles for the consistent use of telematic solutions throughout the entire Finnish main road network. This extensive research project is part of the development of traffic management operations at Finnra. Some of the operations being carried out in the test area are included in EU research projects.

Programme areas

The trial will take three years. It will include the installing of monitoring equipment and information signs, the development of data transfer, information systems and information services, and the assessment of the functioning and impacts of the systems.

The monitoring of road surface conditions will be enhanced in the test area. New types of road weather monitoring points are being installed on the road between Lohjanharju and Salo, and automatic road weather monitoring from a moving vehicle is being developed. Road surface condition forecasting models are also being developed. Information is also being collected more efficiently on traffic incidents and accidents. The collected information will be adapted for use in traffic information services and road network maintenance operations.

Traffic information will be transmitted to road users via the Finnish Broadcasting Company's teletext service, information kiosks at service points, the Internet, radio and via the novelty services based on the radio RDS-TMC traffic information channel and GSM mobile phone technology. Warnings on adverse road surface conditions are displayed on combinations of variable warning and information signs that are installed by the side of the road.

Variable speed limits and the messages displayed on five information signs have been controlled mainly automatically in accordance with the road surface conditions already since the autumn of 1994 on the section of motorway between Kotka and Hamina.

This road weather-controlled road will be extended from Kotka to Pyhtää. Traffic control with variable speed limits will be tried out on this section on a two-lane section of the road.

The functioning and impacts of the data collection and information management systems and information services under development will be assessed in the test area.

This first project pamphlet discusses the thermal mapping of the E18 road and the enhanced road weather monitoring between Lohjanharju and Salo in greater detail.

Thermal mapping on TERN-road E18 between Turku and Vaalimaa

The basis for the enhancement of road weather monitoring was the thermal mapping carried out on the entire E18 road in the winter of 1995-1996. Thermal mapping was used to find out the relative variation in the road surface temperature. The road was divided into eleven sections, each being approximately 35 kilometers in length. The measurements were carried out with two vehicles equipped with infrared thermometers.

The road surface temperature is a complex function of temporal and spacial changes. The time of day, cloudiness, altitude, vicinity of any bodies of water, trees and buildings, the road structure and the amount and type of traffic are among the main factors to be considered. The greatness of the changes depends on the prevalent weather conditions. Thermal mapping is usually carried out when the road surface temperature is somewhere between +10°C and -10°C. The measurements are done after midnight, when the daily variation in road surface temperatures is at its lowest.

The results of thermal mapping have been presented in the thermal mapping report and on thermal maps. The maps illustrate the relatively coldest and warmest sections of the road. The examined area is divided into eight climatic areas, which differ somewhat from one another. Thermal mapping and knowledge of local conditions can be used in determining the locations of new road weather stations more accurately. On the basis of thermal mapping, more reliable conclusions can be reached concerning the status of the road surface condition also on the road sections between measurement points on the basis of road weather data collected at the fixed measurement points.

A model which explains the formation of road surface conditions as a function of a variety of environmental factors, conditions and actions on the basis of information collected at road weather stations is currently being constructed with the use of neural networks. Thermal mapping is also used as the foundation for the development of road surface condition models for predicting road surface conditions.

Road weather monitoring to be enhanced between Lohjanharju and Salo

Road weather monitoring will be enhanced on the approximately 50 km-long road section between Lohjanharju and Salo. 27 of the new type of road weather monitoring station, some road weather cameras and some sensors used to measure traffic have been installed on the road section during the autumn. The software used in the road weather system is being renewed to fit the more modern and inexpensive equipment being used. The aim is to make the road weather data collecting software as applicable as possible, so that the same software can be used to collect data on road weather stations, traffic counting locations, road weather cameras and mobile road weather monitoring stations. The variable message sign control software will also be renewed in order to make it as applicable as possible and suitable for controlling freely programmable signs. The aim is to control both combinations of variable warning and information signs and variable speed limits with the same software.

Four pairs of two-part combinations of variable warning and information signs will be installed on the road between Lohjanharju and Salo. The upper half of the sign can display the 'slippery road', 'road works' or 'caution' warnings. It is possible to display more detailed information concerning the warning in the lower half of the sign on two rows of text. The text is freely programmable. Variable speed limit signs will also be tried out on the road section.

More exact road weather data will be used to enhance the functioning of maintenance operations and to improve the information services for road users. The impacts of enhanced road weather monitoring on road maintenance and the information given to road users will be compared to the situation on roads equipped with standard surveillance equipment and to mobile road surface condition monitoring.

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Transport telematics – E18 test area

Project pamphlet no. 2, November 1996

Development of traffic management data systems

One area of the Transport telematics – E18 test area –programme is the development of an efficient and functioning whole from individual data collection and information management systems. This whole forms a tool that is used in traffic management, the use of which can later partly be expanded throughout the country.

Defining the service database

The logical service database will be a combination of the current separate databases and will enable the flexible use of information from different databases e.g. in traffic information services.

The logical service database is a collection of descriptions, guidelines and parameters used to adapt existing information to fit new requirements. Traffic control and information services also call for totally new methods for use in the production and storage of information. The parts of the service database that are needed for this task include the necessary information obtained from various Finnra systems and information used in information services and traffic control at Finnra. The various stages of data processing and the associated data storage are also defined.

In order to provide a service, the associated information has to be defined; how and where to obtain the information, the location of events associated with the service, the timing of services; the timing of information services, formulating the message and distributing information through different channels.

Pan-European location and event codes are used to formulate the messages. The addresses of the locations of the events are needed in order to combine the information. Three types of addresses are currently in use: the road address (road database), coordinates (map, road weather data) and positioning data (the area, the location that has been encoded for traffic bulletins). Data distribution management includes the supervision and tracking of transmissions. This is done in order to confirm that the correct information is transmitted to the correct media and that the different media do not broadcast bits of information that contradict one another.

The necessary information and functions are first determined from requirements and services onwards. The result is a description of the data system of the logical service database along with its data storage.

Traffic management user interface

The persons responsible for the information services and/or the traffic control systems can obtain the information they want from the service database or upload information into the database by using the traffic management user interface. The user interface allows its users to combine different types of information concerning the road network, traffic, weather, road surface conditions and different types of incidents. The most essential parts of the user interface are the various map grids and tables. Facts are illustrated on the maps by using symbols or e.g. by coloring the roads according to whether the road is slippery, congested, etc.

The user interface is created using Windows and ArcView environments. Ever since October, users have been able to access road weather data on the interface. Information on road works will be added next, and can be accessed by April 1997. By the end of 1997, information on traffic incidents can also be accessed through the user interface.

Renewing the register of road works

Finnra has been using for years a road works database updated by the road regions which transfers information automatically to the Finnish Broadcasting Company's teletext service and to web pages. The register can also be used in phone services, for radio reports, for drawing up a map of the road works and for compiling press releases.

The register of road works had to be redefined last spring in database form for the traffic management user interface.

Information concerning road works can be recorded, used and transmitted to the media and to partners, such as the regional fire brigade control, through the traffic management user interface.

Besides current road works, already-completed road works are also recorded in the road works database. In the future, a foreign database made up of both information on Finnish road works that transmitted abroad and information on road works being carried out in other countries.

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Transport telematics – E18 test area

Programme pamphlet no. 3, May 1998

Projects close to completion

The E18 test area –programme that began in 1996 will be completed by late 1998. Most of the programme's some 50 sub-projects have already been completed or are in their final stages.

The aim of the Transport telematics – E18 test area –programme was to develop an effective and functioning whole from individual data collection, information management and data utilization systems. The impacts and usefulness of tools used in traffic management are assessed in the test area. The information can be used to expand the use of telematics, when appropriate, throughout Finland.

A report will be drawn up on the various projects conducted in the E18 test area by late 1998. This final report will especially examine the combined effects of the various projects. This will give us an idea of what kind of over-all traffic management concept is best suited for Finnish conditions. Other subjects for discussion include determining the areas of transport telematics that Finnra should concentrate on developing in the future and the ways R & D operations could be arranged. In addition to the actual assessments of transport telematics, the final report will also examine the functioning and success of this umbrella project.

As part of the final stages of the E18 test area - programme a combined briefing and discussion will be arranged in the autumn of 1998. The purpose of this event is to provide transport professionals with information concerning the programme and to gather their views on the programme's achievements.

Introduction of programme areas

Traffic and road weather monitoring using camera technology

Two levels of picture quality were tried out in the transmission of camera images from a road in the Uusimaa Region to a Road Traffic Information Center during the slowly updated image – project. The picture quality of slowly updated images has turned out to be fair: details are lost, but this does not cause problems when the images are used. In addition to this, when individual cameras are used, data transmission costs are lower when transmitting a slowly updated image than when transmitting a constant sharp image.

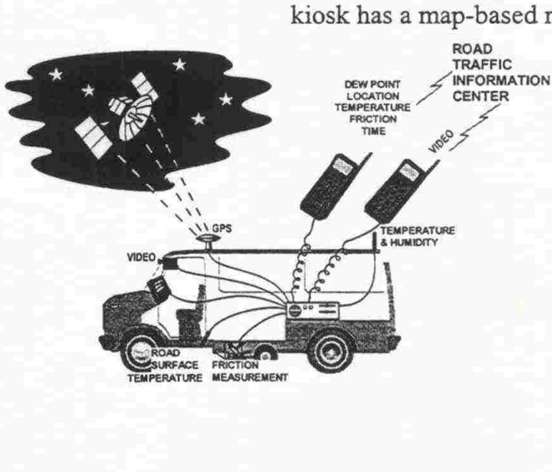
Mobile road surface condition monitoring

The Mobile road surface condition monitoring – project concerns the development of a probe vehicle, which collects road weather data and produces a video image of the weather and road surface conditions when moving on a road. The road weather data, video image and vehicle location data are transmitted from the monitoring vehicle to the Road Weather Monitoring Center by using a GSM telephone. In the future, the video image will be visible at the Road Weather Monitoring Center as a road weather camera image, while the road weather data will be displayed on a map grid in the road weather programme. If these trials go well, there will be an attempt to produce data on the E18 road directly for use Road Weather Monitoring Centers.

Projects associated with traffic information services

The information kiosk project concerned the definition of the services to be provided by Finnra's information kiosks on the basis of the needs of road users. The project suggested the creation of a network of information kiosks, made up of three levels: high-quality "full service" kiosks, kiosks offering basic services (just a user interface) and kiosks connected to commercial networks. An Internet-based information kiosk for road users was constructed at Oluntulli as an information kiosk pilot project. The information kiosk has a map-based route guidance service.

In-vehicle monitoring equipment used in mobile road surface condition monitoring



Users can also obtain information e.g. on road surface conditions, the traffic situation, service stations and hotel and travel services. Information is provided not only by Finnra, but also by local tourist trade organizations and entrepreneurs. The service is entitled NET-info, and is currently in trial use.

The PROMISE project headed by Nokia concerns the development of a personal passenger and traffic information service. The service can be used at terminals hooked up to the Internet. The PROMISE service provides traffic and travel data on several modes of travel, including information on alternative transport modes, routes and available services. Finnra provides the project with information on congestion, the weather and road surface conditions.

Finland, along with 11 other EU countries, has signed a paper expressing the commitment to produce RDS-TMC services. These services will first be tested on the E18 road and on the other main roads in southern Finland. Finnra collects the information that is to be transmitted via the RDS-TMC service and sends it to the Finnish Broadcasting Company, which will start the RDS-TMC trial broadcasts throughout the E18 test area in the summer. The aim is to define a service that is suitable for Finnish conditions, as well as the associated necessary contracts, data systems, etc.

One of the 30 Dynaguide-receivers obtained from Volvo has been in trial use, installed in a car, since the beginning of the year, and the memory card is almost ready. A demonstration will be done to coincide with the EU-funded Force- and Ecortis-projects.

Variable speed limits

In Finland, the trials of variable speed limits have mainly been carried out on the E18 test area.

Automatic, weather- and road weather-controlled variable speed limits have been used on the section of motorway between Kotka and Hamina since 1994. A two-lane extension of this weather-controlled road was introduced between Pyhtää and Kotka in late 1997. The road section has a total of 67 speed limit signs, the speed limits displayed on which vary between 60 and 120 km/h according to weather and road weather data provided by road weather stations. There are also 13 combinations of variable warning and information signs in use. They are used to warn road users not only of adverse road surface conditions, but also other factors, which may impede traffic. Variable speed limits are used on the E18 roadalso between Helsinki and Turku. In the Uusi maa road region, weather- and road weather-controlled variable speed limits are in use between Lohjanharju and the border of the Turku road region. The Turku road region has recently introduced variable speed limits between Salo and the border of the Uusimaa road region. The Turku road region intends to have variable speed limits also in use on the road between Salo and Paimio sometime in 1998.

Impacts of variable speed limits

A study was completed on the impacts of the traffic control system based on weather and road weather data on the Kotka-Hamina motorway in 1997.

According to the study, weather control had a positive impact on traffic safety by reducing the mean speed and the standard deviation of driving speeds. The system did not appear to have an impact on the distances between cars.

In the winter, the lowering of the speed limit from 100 to 80 km/h reduced the traffic mean speed by about 3 km/h in addition to the effects of the road surface conditions (about –6 km/h). When drivers had difficulties detecting slipperiness, the system reduced driving speeds by about 5 km/h.

In the summer, the speed limit would mainly be changed if there was a risk of waterplaning. The lowering of the speed limit from 120 to 100 km/h reduced the mean speed of cars travelling in free flow traffic by about 5 km/h in addition to the effects of adverse road surface conditions (-2 km/h), while the corresponding reduction in mean speeds was about 8 km/h when the speed limit was reduced from 120 to 80 km/h (adverse road surface conditions have an effect of about –6 km/h).

Still a lot to do

Some of the projects being conducted on the E18 test area will not be completed by the end of the E18 programme. The results obtained in these projects by the end of the programme will be utilized when drawing up a summary of the significance and benefits of the test area. The actual development projects will go on after the E18 test area –programme has ended as independent projects or as parts of other umbrella projects.

The projects that will continue after the E18 test area –programme has ended include e.g. the development of Finnra's logical service database and the associated traffic management user interface, and the further development of RDS-TMC services.

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Transport telematics – E18 test area

Programme pamphlet no. 3, November 1998

The projects included in the programme have been divided into the following four programme areas:

- Development of data collection
- Development of information management
- Development of the distribution of data
- System and impact assessment.

The development of data collection has included improving the quality of basic data by utilizing existing systems and, if necessary, by developing these systems further. Data collection was enhanced, and the analysis of data in databases was increased.

A general service database solution was developed for use in information management. Clear connection interfaces corresponding with Finnra's and Pan-European telematics architecture were defined for use in data collection and distribution for different applications as regards the contents and the form in which the data is presented. The impacts of these solutions on the traffic and road maintenance were assessed. The system as a technical solution and the system's economic feasibility were also evaluated.

The following is a list of all the projects in the programme divided by programme area. The project contacts can provide additional information on the results of each project.

DEVELOPMENT OF DATA COLLECTION

	Project	Contact
A1	Thermal mapping of the E18 road	Yrjö Pilli-Sihvola
A2	Road surface classification based on road weather data	Yrjö Pilli-Sihvola
A3	Enhanced road weather monitoring between Lohjanharju and Salo	Juha Ylikorpi
A4	Road weather monitoring using a sensor vehicle	Jukka Savolainen
A5	Tracking system for maintenance vehicles	Juha Ylikorpi
A6	New road weather and traffic data collecting software	Jouko Kantonen
A7	Road weather camera images into the road weather system	Kimmo Toivonen
A8	Image transfer through the data network	Pekka Rajala
A9	Collecting data on traffic incidents and accidents	Jorma Helin
A10	Development of traffic monitoring based on digital image processing	Pekka Rajala

DEVELOPMENT OF INFORMATION MANAGEMENT

	Project	Contact
B1	Needs for change in the road weather system, a prestudy	Yrjö Pilli-Sihvola
B2	Definition and development of a logical service database	Marja Koski
B3	Definition of technical architecture and uses of the service database	Marja Koski
B4	New register of road works	Marja Koski
B5	Traffic management user interface	Jorma Helin
B6	Road surface condition model	Yrjö Pilli-Sihvola
B7	Availability of weather model data	Yrjö Pilli-Sihvola
B8	Development of road surface classification for controlling variable speed limits	Yrjö Pilli-Sihvola

DEVELOPMENT OF THE DISTRIBUTION OF DATA

	Project	Contact
C1	Concept for traffic information kiosk	Maritta Polvinen
C2	Pilot at Ouluntulli: On-line information service for road users	Markku Tervo
C3	Car ferry traffic information services in the Turku Region	Pekka Liimatainen
C4	Displaying information on the Internet	Yrjö Pilli-Sihvola
C5	WIND (Weather Information and Distribution Services) WIND (Weather Information and Distribution Services)	Markku Tervo
C6	Implementation real-time traffic information service homepage	Maritta Polvinen
C7	RDS-TMC service in the E18 area	Martin Johansson
C8	PROMISE, GSM traffic information services	Sami Luoma
C9	Variable speed limits at the Uusimaa Region	Pekka Rajala
C10	Variable speed limits at the Turku Region	Juha Ylikorpi
C11	Variable speed limit trial between Pyhtää and Kotka	Yrjö Pilli-Sihvola
C12	Combinations of variable warning and information signs on the roads between Salo and Lohjanharju and between Pyhtää and Kotka	Juha Ylikorpi Pekka Rajala Yrjö Pilli-Sihvola
C13	Trial of improved software for road surface condition classification in control of variable speed limits on the road between Kotka and Hamina	Kimmo Toivonen
C14	Operating principles of variable road surface condition message signs and the maintenance and construction principles of these systems	Kimmo Toivonen
C15	Hypermedia presentation of weather-controlled road	Kimmo Toivonen

IMPACT ASSESSMENT

	Project	Contact
D1	Effects of weather-controlled traffic management system in the motorway section between Kotka and Hamina	Yrjö Pilli-Sihvola
D2	Impact study of trial of enhanced weather monitoring system	Yrjö Pilli-Sihvola
D3	Mobile road surface condition monitoring	Jukka Savolainen
D4	The impact of variable speed limits on a single carriageway road	Yrjö Pilli-Sihvola
D5	The socio-economic profitability of the Kotka-Hamina weather-controlled road	Mirja Noukka
D6	The impacts of variable road surface condition message signs on driver behavior	Yrjö Pilli-Sihvola
D7	Bilingual variable message signs – driver opinions and visual load	Mikko Karhunen
D8	Effects of variable message signs on recall of fixed warning signs	Mikko Karhunen
D9	Study of the structure of RDS-TMC messages	Martin Johansson
D10	RDS-TMC – technical evaluation	Martin Johansson

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Finnra
Road Administration

Transport telematics – E18 test area, publications 1996-1998

Finnra reports and internal publications:

Harjula, V. (1998). Kaksikieliset muuttuvat opasteet – kuljettajien mielipiteet ja visuaalinen kuormittuminen. Tielaitoksen selvityksiä XX/1998. (luonnos) [Bilingual variable message signs – driver opinions and visual load. Finnra report XX/1998. (draft)]

Luoma, J., Harjula, V. ja Penttinen, M. (1998). RDS-TMC -viestien ymmärrettävyyden kehittäminen. Tielaitoksen sisäisiä julkaisuja 20/1998. TIEL 4000184. Tiehallinto, Liikenteen palvelut. [Development of the comprehensibility of RDS-TMC messages.]

Luoma, J., Rämä, P., Penttinen, M. ja Harjula, V. (1997). Muuttuvien keliopasteiden vaikutukset kuljettajan toimintaan. Tielaitoksen selvityksiä 22/1997. TIEL 320 0469. Tiehallinto, Liikenteen palvelut.. [The impacts of variable road surface condition message signs on driver behavior.]

Lähesmaa, J. (1997). Kotka-Hamina sääohjatun tien yhteiskuntataloudellisuus. Tielaitoksen selvityksiä 36/1997. TIEL 320 0482. Tiehallinto, Liikenteen palvelut. [The socio-economic profitability of the Kotka-Hamina weather-controlled road.]

Malmivuo, M. ja Pajunen, K. (1998). Tehostetun kelinseurantajärjestelmän kokeilu. Tielaitoksen selvityksiä XX/1998. (luonnos) [The experiment of enhanced weather monitoring system. Finnra report XX/1998. (draft)]

Nurminen, I. (1998) Kelitiedotuksen multimedia-demonstraatio. Tielaitoksen sisäisiä julkaisuja 27/1998. Tiehallinto, Liikenteen palvelut. [Road weather information multimedia demonstration. Finnra internal publications 27/1998. Road Authority, Traffic Services.]

Raitio, J. (1998). Sään ja kelin tunnistaminen muuttuvien nopeusrajoitusten ohjaamiseksi Kotka–Hamina -moottoritiellä. Helsinki 1998. 92 p. + app. 31 p. [Recognition of Weather and Road Conditions for Control of Variable Speed Limits at Kotka-Hamina Motorway.]

Rämä, P. (1998). Muuttuvien nopeusrajoitusten vaikutukset yksiajorataisella tiellä. Tielaitoksen selvityksiä XX/1998. (luonnos) [The impact of variable speed limits on a single carriageway road. Finnra report XX/1998. (draft)]

Rämä, P. (1997) Sää- ja kelitietoon perustuvan liikenteen ohjausjärjestelmän vaikutukset Kotka - Hamina -moottoritiellä. Tielaitoksen selvityksiä 1/1997. TIEL 320 0488. Tiehallinto, Liikenteen palvelut. [Effects of the weather-controlled traffic management system in the motorway section between Kotka and Hamina.]

Tielaitos (1996). Liikenteen tiedotuspistekonsepti, "Uusi Tieinfo"; Tielaitoksen sisäisiä julkaisuja 25/1996. Keskushallinto. [Finnra (1996). Traffic information kiosk concept, "New Tieinfo"; Finnra internal publications 25/1996. Central administration.]

Tielaitos (1997). Loogisen palvelutietokannan kuvaus. Tielaitoksen sisäisiä julkaisuja 3/1997. Tiehallinto, Liikenteen palvelut. [Finnra (1197). Description of the logical service database. Finnra internal publications 3/1997. Road Authority, Traffic Services.]

Other reports and memos:

Alastalo, A. (1998). Tiesääjärjestelmästä Turun tiepiirin alueella välillä Muurla–Sammatti. [Road weather system in the Turku Region between Muurla and Sammatti.]

Annala, J. (1998). Kokemuksia tiesääasemien toiminnasta sääohjatulla tiellä Karhula–Siltakylä. Kouvola 4.12.1998.. [The operation of road weather stations on the weather-controlled road between Karhula and Siltakylä.]

Behrendt, F., Schedler, K., Scheiderer, T., Tervo, M., Tervonen, R. (1997). WIND (Weather Information and Distribution Services) Report for Publication.

Harjula, V., Luoma,J. ja Rämä, P. (1998). Effects of Bilingual VMS on Information Overload. TROPIC Trial Phase. WP12, D12.3, Overload Summary Report.

Harjula, V., Luoma,J. ja Rämä, P. (1998). Acceptance of VMS Displaying Bilingual Messages by Turns. TROPIC Trial Phase. WP12, D12.3, Overload Summary Report.

Intrsinsic (1996). Liikenteen hallinnan käyttöliittymä. Projektisuunnitelma [Traffic management user interface. Project plan.]

Intrinsic (1998). Liikenteen hallinnan käyttöliittymä – tietyötiedon hallinta. Käyttöliittymän kuvaus. [Traffic management user interface – management of road works data. Description of user interface.]

Intrinsic (1996). Windows/NT -keräilyohjelmisto, Toiminnallinen määritys. Versio 16.10.1996 [Windows/NT-collecting software, Functional definition.]

Intrinsic (1998). Windows NT-Keskusasemaohjelmisto, Toiminnallinen määritys, V2.0.0, 02.01.1998 [Windows NT-server software, Functional definition.]

Intrinsic (1998). Windows NT-keruuohjelmisto, Suunnitteludokumentti, V1.0.0, 07.01.1998 [Windows NT-collecting software, Planning document.]

Kaarto, S. (1998). GPS-ajoneuvoseuranta Turun tiepiirissä. . [GPS vehicle tracking in the Turku Region.]

Kauste, E., Pilli-Sihvola, Y. ja Portaankorva, P. (1998). Valtatien 7 (E18) sääohjauksen jatkaminen välillä Kotka - Pyhtää, Yhteenvetoraportti. Tiepiirin julkaisu 3/1998. Kaakkois-Suomen tiepiiri, Liikenteen palvelut. [Continuation of weather control system on highway 7 (E18) between Kotka and Pyhtää, Summary report. Finnra publication 3/1998. Kaakkois-Suomi Region, Traffic Services.]

Luoma, J., Harjula, V. ja Rämä, P. (1998). Effects of Fibre Optic VMS Technology on Information Overload. TROPIC Trial Phase. WP12, D12.3, Overload Summary Report.

M. Nesti, editor (1998). Report on Improved and Validated Automatic Test Sites. TROPIC deliverable D9.4.

Oulun tiepiiri (1997). Ouluntullin pilotti: Internet-pohjainen tienkäyttäjän informaatio on - line palvelu, väliraportti 12/1997. [Oulu Region (1997). Ouluntulli pilot: On-line information service for road users, interim report 12/1997.]

Oulun tiepiiri (1998). Ouluntullin pilotti: Internet-pohjainen tienkäyttäjän informaatio on - line palvelu, loppuraportti 9/1997: Yhteenveto tuloksista. [Oulu Region (1998). Ouluntulli pilot: On-line information service for road users, final report 9/1997: Summary of findings.]

Rajala, P. (1998). Digitaalinen kuvansiirto. [Digital image transfer.]

Rämä, P. edit. (1998). Display Test Site Report. TROPIC, WP7, D07.2

Saarikivi, P. (1996). Kelimallit. Tutkimus tielaitokselle. Helsinki 31.3.1996[Road surface condition models, A study for Finnra.]

Saarikivi Weather & Law Oy (1996). Säämallidatan saatavuus ja hinnat. Viking-selvitys Tielaitokselle. Helsinki 25.11.1996. [Availability and prices of weather model data, Viking-study for Finnra.]

Tervo, M., Tervonen, R. (1997). Workpackage raport – WP 7. WIND On-line Service.

Tielaitos [Finnra] (1996). Sääohjatun tien jatke vt 7 (E18). Liikenteen ohjausjärjestelmän yleissuunnitelma välille Siltakylä–Kotka. Tielaitos, Kaakkois-Suomen tiepiiri. [General plan for traffic controlling system between Siltakylä and Kotka]

Tielaitos [Finnra] (1996). TITY-uudelleenmäärittely. Tielaitos, Liikenteen palvelukeskus/Tie-Data 7.6.1996. [Redefining the register of road works]

Tielaitos [Finnra] (1997). Sääohjattu tie vt7 (E18) Siltakylä - Summa. Muuttuvien opasteiden ohjausperiaatteet. Kaakkois-Suomen tiepiiri, Liikenteen hallinta ja palvelut. [Weather-controlled highway 7 (E18) between Siltakylä and Summa. Operating principles of variable message signs. Kaakkois-Suomi Region, Traffic management and Services.]

Tielaitos [Finnra] (1998). Liikennekeskusten toiminnallinen analyysi. [Functional analysis of Road Traffic Information Centers]

Tielaitos ja Intrinsic Oy (1995). Tiesääjärjestelmän muutostarpeet – Esikartoitus 10.11.1995. [Finnra and Intrinsic Oy (1995). Needs for change in the road weather system – Prestudy 10.11.1995.]

Toivonen, K. (1997). E18-tien kelikameroiden kuvat tiesääjärjestelmään. Tielaitos. . [Road weather camera images from the E18 road into the road weather system. Finnra.]

Toivonen, K. (1997). Sääohjattu tie, Muumitalon toipumissuunnitelma. Tielaitos, 24.4.1997 [Weather-controlled road, Recovery plan for the technical building.]

Toivonen, K. (1998). Hypermediaesitys sääohjatusta tiestä. Tielaitos. [Hypermedia presentation of a weather-controlled road. Finnra.]

Toivonen, K. (1997). Sääohjattu tie, tietoturvakartoitus. Tielaitos, 24.4.1997. [Weather-controlled road, data security investigation.]

Traficon (1998). Liikennekeskusten toiminnallinen analyysi. (luonnos) [Functional analysis of Road Traffic Information Centers. (draft)]

Vaisala (1996). E18 – Lämpökartoitusraportti; talvi 1995/1996.. [E18 – Thermal mapping report; winter 1995/1996.]

Vaisala (1996). E18 – Lämpöprofiili; talvi 1995/1996. [E18 – Thermal profile; winter 1995/1996.]

Vägverket ja Tielaitos (1997). Förstudierapport projekt Ferry. (Framkomlighetsinformation på färjor).

PROMISE publications:

D3.1 Specification of PROMISE Services (7/1996)
D7.1 Evaluation plan for PROMISE (7/1996)
D4.1 Generic PROMISE System Architecture (10/1996)
D3.2 PROMISE Service Chain and Specification of Test Site Service Applications (9/1997)
D7.3 PROMISE System Verification (10/1998)
D8.1 The Business Case for PROMISE Services (1/1999)
D7.4 Final Evaluation Report of PROMISE demonstrations (1/1999)
D2.1 Summary of PROMISE Public Relations Activities (1/1999)

Brochures:

- Sääohjattu tie Kotka-Hamina (kieliversiot: suomi, englanti, ruotsi, venäjä) [Weather-controlled road between Kotka and Hamina (in Finnish, English, Swedish, Russian)]
- E18 Tieliikenteen telematiikka – tienkäyttäjän parhaaksi (lokakuu 1996)
- E18 Road Transport Telematics – Serving the Road User (lokakuu 1996)

Programme pamphlets:

- Project pamphlet no 1, October 1996
- Project pamphlet no 2, November 1996
- Progress Report No. 1, July 1996
- Project pamphlet no 3, May 1998
- Project pamphlet no 4, 18 November 1998

Videos:

- Sääohjattu tie Kotka–Hamina. Kaakkois-Suomen tiepiiri 1995. [Weather-controlled road between Kotka and Hamina (in Finnish, English, Russian, French). Kaakkois-Suomi Region 1995.]

Papers:

SIRWEC, Birmingham 17.-19.4.1996

- Pilli-Sihvola, Y.: Weather Related Traffic Management - E18 Finnish Test Area
- Toivonen, K.: Technical Description of the Weather Controlled Road in South-Eastern Finland
- Kantonen, J.: Road Weather and Road Conditions Services for Motorists

ISATA, Firenze 3.-6.6.1996

- Noukka, M. ja Hirvenoja, E.: Road Transport Telematics for Nordic Conditions

TRB, Reno 11.-16.8.1996

- Pilli-Sihvola, Y.: Weather Related Traffic Management - E18 Finnish Test Area
- Kantonen, J. ja Toivonen, K.: Road Weather and Road Conditions Services for Motorists

3th ITS World Congress, Orlando 14.-18.10.1996

- Muurinen, I. ja Kokkinen, M.: Matheus and Winter: The Experience In Finnish Road and Traffic Management

Forskardagar, Linköping 8.-9.1.1997

- Penttinen, M.: Bilförares informationsbehov

TRB, Washington 12.-16.1.1997

- Rämä, P. ja Luoma, J.: Driver Acceptance of Weather-controlled Road Signs and Displays?
- Leppänen, A.: Winter Maintenance with help of Weather Information System in Finland

4th ITS World Congress, Berliini 21.-24.10.1997

- Pilli-Sihvola, Y.: Experiences of the implementation of the weather-controlled traffic signs on E18 motorway, 1994-1996
- Rämä, P.: Effects of weather controlled traffic management system on driver behaviour

9th SIRWEC conference, Luleå 15.-17.3.1998

- Toivonen, K. ja Kantonen, J. New Development Phases of the Finnish Road Weather Information System.
- Leviäkangas,P. ja Pilli-Sihvola Y. Customer-oriented services and functions of road weather and traffic information centres (RWTIC)

Xth PIARC International Winter Road Congress, Luleå 16.-19.3.1998

- Leviäkangas, P.: Improvning Winter Road Management Under Euro-regional Project "Viking"
- Muurinen, I. ja Kokkinen, M.: Matheus and Winter: The Development and Experience In Finnish Road and Traffic Management

5th ITS World Congress, Seoul 12-16.10.1998

- Harjula, V., Luoma, J., ja Rämä, P.: Acceptance of variable message signs displaying bilingual messages by turns.

Sensing and Controls with Intelligent Transportation Systems, Boston 2.-5.11.1998

- Raitio, J. ja Kulmala, R.: Weather and road conditions for control of variable speed limits

Second Urban Environment Symposium, 2.-6.11.1998, Albuquerque, New Mexico

- Pilli-Sihvola, Y.: Road Weather Information System in Finland and Cost Benefit Studies.
- Toivonen, K.: Road Weather and Road Conditions Services for Motorists.

TRB, Washington 10.-14.1.1999

- Pilli-Sihvola, Y. ja Schirokoff, A.: Finnish Concept for Transport Telematics – E18 as a Test Area

- Portaankorva, P.: The Traffic Management Policy of Variable Message Signs for Weather-Controlled Road Between Pyhtaa and Hamina, Finland
- Rämä, P.: Effects of weather controlled variable speed limits and warning signs on driver behavior.

A1 Thermal mapping of the E18 road

Vaisala Oy (1996). Lämpökartoitusraportti, talvi 1995/96 [Thermal mapping report, winter 1995/96]

Thermal mapping measures local variations in the minimum road surface temperatures at night. The measurements are done on three different types of outgoing radiation: maximum outgoing radiation, average conditions and minimal outgoing radiation. The difference between the road surface temperature and the air temperature is at its greatest during the maximum outgoing radiation.

The measurements are carried out with a moving vehicle equipped with an infrared thermometer and equipment used to record the results. The measurements are later analyzed and then placed on a map grid as diagrams representing the difference between the minimum road surface temperature and average conditions. These figures give an idea of the different locations and proneness of road sections for ice formation when temperatures are close to zero.

The thermal mapping of the E18 road was carried out in November 1995 on a 350-km road section between Naantali and Vaalimaa. The road section had been divided into 19 sections, each about 35 km long. The thermal mapping was carried out using two specially equipped thermal mapping vehicles. The measurements for each section were done in the maximum, average and minimal temperature conditions.

The result of the thermal mapping was a report analyzing the climatic conditions on the E18 road, examining the factors associated with the differences in temperatures and introducing potential locations for road weather stations. The report included a thermal map illustrating the temperature conditions for the entire road section and the differences in road surface temperatures in different conditions in comparison to the longitude and altitude of the road. The thermal map also describes the environmental factors affecting road surface temperatures on each road section.

A2 Road surface classification based on road weather data

Juha Raitio: Sään ja kelin tunnistaminen muuttuvien nopeusrajoitusten ohjaamiseksi Kotka - Hamina -moottoritiellä. [Recognition of Weather and Road Conditions for Control of Variable Speed Limits at Kotka-Hamina Motorway] Helsinki 1998. 92 pg. + app. 31 pg.

Keywords: statistical pattern recognition, k-nearest neighbour classifier, self-organizing map, traffic control, variable speed limits

Weather and road conditions affect road safety significantly especially in the Nordic countries, where wintertime introduces special conditions that raise the accident risk significantly. Studies have shown that drivers in general adapt their behavior poorly according to varying conditions. Drivers do not easily perceive conditions like slippery roads. Since 1994 the speed limits on a 14-km section of the E18 motorway between Kotka and Hamina have been controlled on the basis of weather and road conditions. The automatic control of the 36 variable speed limit signs is based on measurements of the weather and road surface by two road weather stations. The aim of this so-called weather-controlled road is to adapt driver behavior by providing suitable speed limits and information according to the weather, road and traffic conditions. The aim of the control system is to recognize poor, moderate and good weather and road conditions, according to which one of the speed limits of 80, 100 or 120 km/h is introduced. The purpose of this work is to study suitable methods for enhancing the reliability of the recognition system so that the speed limits introduced are appropriate or seldom higher than appropriate.

The material has been collected by observing the weather and road conditions manually at locations near the road weather stations. The road weather station data was then calibrated on the basis of manual observations and the requirements of each speed limit. Over 800 observations were made by the Finnish National Road Administration. By applying the theory and methods of statistical pattern recognition, the conditions measured by the road weather stations are classified into one of the road surface condition classes to provide appropriate speed limits. The Bayesian error criterion, which minimizes the overall misclassification rate, and the Neyman-Pearson error criterion, which fixes one of the error probabilities and minimizes the others, are applied in classifier design. The classifiers tested are the k-nearest neighbour classifier and the Self-Organizing Map. Features of highly correlated measurements are extracted utilizing the Karhunen–Loève expansion.

The performances of several methods are compared. The performance of a classification method is assessed through cross-validation and interval estimation. The best results are gained by using a k-nearest neighbour classifier. This reduces the error probability in recognition from 50% to roughly 20%. The Neyman-Pearson criterion is found to be useful in restricting the worst type of misclassification errors to a minimum. To further improve the reliability of the recognition system, it is suggested that extra, high-quality material is collected, and methods that utilize the contextual information in the time-series and measurements of the other road weather stations are applied.

A4 Road weather monitoring using a sensor vehicle

Lampinen, A., LIIKKUVA KELIN MITTAUS, Liikkuvan kelimittarin kehittäminen, Tutkimusraportti 3/93, [SafeDrive, Research report] AL-Engineering Oy, Espoo.

In 1996, Finnra started a programme entitled "Transport telematics – E18 test area". The aim was to develop a data collection, information management and data utilization system associated with telematics to increase traffic efficiency, safety and comfort. The system will utilize not only the existing infrastructure, such as road weather stations, traffic monitoring stations, weather radar, camera points and road weather monitoring centers, but also real-time information on actual road and friction conditions.

One of the programme areas was "Road weather monitoring using a sensor vehicle", for which there was no existing equipment or method available. There are many different kinds of friction testers in different countries and for different purposes. The problem with these friction testers is mainly the fact that they are either towed behind vehicles or are groups of vehicle equipment, which cannot be used the way they should be used in this project, i.e. they cannot be installed e.g. on buses and lorries or be used as separate "research vehicles".

As opposed to a friction tester, a probe vehicle for friction monitoring, such as SafeDrive, is a piece of equipment combining a friction tester and sensors that monitor road and weather characteristics. Friction monitoring measures the road surface and air temperature as well as the air humidity, which can be used to define the dew point temperature.

The SafeDrive probe vehicle developed during this project can be described by the following characteristics:

1. SafeDrive measures the friction that exists between the pavement and the tyre, the "side force friction", physically. In other words, SafeDrive is mechanical, as there is no way that friction can be measured without physical contact with the road surface.
2. The SafeDrive equipment can be installed in buses.
3. The accuracy of SafeDrive's real-time DGPS positioning system is about 2 m (x/y).
4. SafeDrive is equipped with a real-time data transfer system (GSM-Data service).
5. The transmitted data includes the essential data as regards Road Weather Monitoring Centers, i.e. the average and minimum friction coefficients, the standard deviation of the friction coefficient and the temperature and dew point value of the pavement.
6. The equipment is raised and lowered manually for now. The end product, however, is automated, i.e. works independently of the driver.
7. SafeDrive has error diagnostics, which raise the equipment away from the road surface if necessary.
8. Information concerning the road condition can also be collected as still video images, and the images can be sent to a Road Weather Monitoring Center in real time.

Only two SafeDrive systems exist at the moment, one at Finnra and one at AL-Engineering Oy. The Technology Development Center has supported the development of the SafeDrive system.

A5 Tracking system for maintenance vehicles

Seppo Kaarto. GPS–ajoneuvoseuranta Turun tiepiirissä. Turun tiepiiri. [GPS vehicle tracking in the Turku Region. Turku Region.]

The Turku Road Weather Monitoring Center started trials on vehicle tracking using a GPS system during the winter maintenance operations on main roads in the autumn of 1996. The GPS equipment purchased by the maintenance stations of Raisio, Salo and Paimio situated along the E18 road consisted of eight pieces of in-vehicle equipment and control room software for the Road Weather Monitoring Center.

Price development has been good for the past few years, and the system was believed to bring several benefits e.g. to the Road Weather Monitoring Center's operations management center trial.

Geostar Oy was chosen to provide the systems. The system that was chosen out of the wide variety of alternatives available includes in-vehicle GPS-receivers and Mobitex-modems (Aplicom). The Mobitex radio network is used to transmit information. The road weather monitoring center has control room software and a Mobitex radio modem. The control room software is a Dos-based map user interface tailored to meet the needs of the Road Weather Monitoring Center.

The system was being tested and developed in the autumn of 1996. Geostar Oy provided training for Road Weather Monitoring Center duty personnel and drivers. There were some initial problems with Mobitex-data. The control room software map user interface also required software changes in order to meet the needs of the Road Weather Monitoring Center.

The actual use of the system began in the spring of 1997, though the system was still being developed.

There were many positive experiences. Hence, the Road Weather Monitoring Center work group decided to suggest to the regional management that more of the tracking system equipment should be purchased. The aim was that all maintenance units in the Region should have GPS equipment that would be used on the main road network (the IS and I classes). The work group suggested the purchase of 15 additional pieces of equipment. This proposition also mentioned the goal concerning the use of the equipment in the summer, which should be developed.

15 additional pieces of GPS equipment were purchased in the summer of 1997, and were installed by autumn. Four of these were combined with a vehicle terminal and a keyboard (Aplicom DT-3000). Now there is a total of 23 pieces of equipment in use in the Region. Control room software user interfaces were also purchased for all of the maintenance stations. Telecommunications were developed by obtaining a "Mobiserver" for the road weather monitoring station to channel all telecommunications through a single Mobitex radio modem. This made it possible for duty personnel to use more than one control room user interface at a time (maintenance mtations).

New users were given training.

The changes made to the system in the autumn of 1997 caused some problems, which were, however, solved relatively quickly.

During the winter, use of the system became more routine and the system was found to be very useful. Temporary operations breakdowns even proved to be irksome.

GPS tracking has been carried out at this stage to assist operations at road weather monitoring centers. The status of road maintenance operations can now be assessed quickly and easily at the centers. "When a vehicle has been called for instance to perform some snow ploughing or salting, we can monitor the task in real time. We no longer have to request information on vehicle locations and the status of the operation from the fleet by phone. Instead, we can now tell the maintenance stations the location and status of the fleet right away."

A6 New road weather and traffic data collecting software

Intrinsic (1998). **Windows/NT -keräilyohjelmisto, Toiminnallinen määritys. Muistio.** [Windows NT –collecting software. Functional definition. Memo]

The aim of the report is to describe the general functioning of the new Windows/NT-based data collecting and management software. The new software is used to replace the old Unix-based data collecting and management software.

The data system collects, processes and records data concerning traffic conditions to be presented through different media and to be used in manual and automatic traffic control. The system also makes it possible to transfer information to other systems, to monitor connections and to invoice.

The report gives descriptions of the system structure, the functioning of data collection, the transfer of data from monitoring stations, the recording of data in a database, the counting of control and alarm messages and the monitoring of system functions.

A7 Road weather camera images in the road weather system

Kimmo Toivonen (1998). **E18-kelikamerakuvat tiesääjärjestelmään. Muistio.** [Road weather camera images from the E18 road into the road weather system. Memo.]

The aim was to transmit all of the road weather camera images from the E18 road to the weather and camera picture server. When the weather and camera picture server has all of the images, all Road Weather Monitoring and Road Traffic Information Centers can use them. The regional contacts are Seppo Kaarto in Turku, Pekka Rajala in Helsinki and Kimmo Toivonen in Kouvola.

Road weather camera image data collection PCs collect images from road weather cameras through a normal optional phone line.

The road weather camera image data collection PC for Kouvola was installed in the network and defined a network drive connection with the kasntas2-weather and camera picture server. The road weather camera image data collection PC for Turku was also installed in the network and defined a network drive connection with the kasntas2-weather and camera picture server. The Uusimaa Region announced that it had no road weather cameras on the E18 road. The Region´s road weather camera image data collection PC is therefore not yet connected with the weather and camera picture server.

Images are primarily collected in the winter, from October to April.

B2 Definition and development of a logical service database

Loogisen palvelutietokanna kuvaus. Helsinki 1997. Tielaitos, tiehallinto, liikenteen palvelut. Tielaitoksen sisäisiä julkaisuja 3/1997. [Description of the logical service database, Finnra internal publications.]

Keywords: information systems, traffic management, road user information, traffic control

Traffic management demands highly complex data on the amount of traffic, traffic incidents, road surface conditions etc. Traffic is mainly controlled through traffic signals and variable message signs, and information services are used to complement control actions.

Traffic information services utilize all channels available. The traffic situation can be checked before a trip by using teletext or the Internet. The same data can be accessed during the trip at information kiosks in rest areas. Several traffic-related programmes are broadcast on the radio, and information on sudden incidents can also be broadcast as RDS traffic bulletins that can interrupt other programs. Up-to-date traffic information can be received right in the car as GSM and RDS-TMC messages, while traffic management centers provide a round-the-clock telephone service for road users. In addition to these information services, a map of road works is published annually and current matters concerning traffic are presented in both national and local newspapers.

Information is exchanged with outside organizations (e.g. the Finnish Meteorological Institute, the police, regional fire brigade controls, municipalities) and with traffic management centers in other countries.

Most essential information is obtained through existing systems, such as the road- and road works databases, the road weather system, traffic monitoring system and traffic control methods.

A so-called logical service database is being developed in order to make it easier to obtain and process data. The service database could be used to find the necessary information quickly, to process and combine this information as needed and then to compose bulletins and messages for different kinds of media. The aim was for the telecommunications and composition of messages to take place as automatically as possible. These automatic operations call for clear operating guidelines and parameters. Operations with outside organizations and other countries are based on standards agreed together. The service database is thus a set of descriptions, guidelines and standards.

The traffic management user interface provides the persons in charge of information services with a uniform way of looking at information in different systems.

The management of data distribution makes sure that the various media are given the correct information at the correct time and that the different media do not broadcast contradictory information.

This reports gives an outline of the idea of the service database, starting with a description of the contents of the "logical service database": the information required for traffic management, the systems which produce information and outgoing services which use the media. The necessary operating guidelines are also roughly outlined. The actual design of the service database is a separate task, which will be started during the next stage of the project.

B5Traffic management user interface

Intrinsic. Liikenteen hallinnan käyttöliittymä - tietyötiedon hallinta. Käyttöliittymän kuvaus [Traffic management user interface – management of road works data. Description of interface.]

The aim of the project is to give a description of Finnra's traffic management user interface as regards the management of road works data. The application goes by the abbreviation TITY.

The report contains a general description of the management of road works data. As regards road works, a description is given of the different functions associated with the system: the inputting, reading, updating and reporting of data. The report contains a description of the information content of the road works data system as well as forms and report models for data inputting and reporting both as a table and on a map.

B6 Road surface condition model

Saarikivi Weather & Law Oy, KELIMALLIT, [Road surface condition models.] FT Pirkko Saarikivi

It is very challenging to make road weather predictions, i.e. predictions concerning the condition of the road surface and the layer of air close to the road surface. In addition to temporally and regionally accurate weather forecasts (especially concerning the temperature and possible snow and sleet), reasonably correct estimates should also be made e.g. of the possible slipperiness and iciness of the road, the amount of slush or snow on the road and the amount of packed snow or ice on the road. The road surface radiation balance and changes in humidity provide indications of the formation and evaporation of ice or frost. Whirling snow and fog can also impede visibility. Because of the complex physical processes associated with predictable quantities, road surface condition models are in the early stages of their development in comparison with weather models.

The study examined the status of road surface condition models in Europe, the USA and Japan.

The perfect road surface condition model is yet to be developed, but the necessary contents of such a model can be determined theoretically. It is at least possible to distinguish the following sections:

1. Road surface temperature model (RST model), which calculates the road surface radiation balance and the changes in temperature and humidity. The assessment of cloud conditions is an important component of this section. Advance thermal mapping can help classifying road sections according to their temperatures' sensitivity to change.

2. A rain model for estimating the duration, type and intensity of the rain. The model can combine extrapolations based on observations made by weather radar with meso-model rain forecasts.

3. A model for assessing whirling snow and its impacts on visibility on the basis of the wind, fallen snow and the temperature.
4. A fog model; typically a one-dimensional model used to assess the probability of fog on the basis of changes in the temperature, humidity and windiness of the layer of air close to the road surface.
5. Snow and ice models, which describe the changes in the ice that has formed on top of fallen snow or the road surface, so that the condition of the road surface can be assessed. The ideal model should also be able to take maintenance actions (salting, snow ploughing) into consideration.

In Finland, the development possibilities of an advanced, versatile and functioning road surface condition model are excellent. The development (the HIRLAM-group) and study (Finnish Meteorological Institute and University of Helsinki) of operative weather models is some of the best in the world. Renewal of the national supercomputer will increase the accuracy of models during the next few years. The dense network of road weather stations and radars provide good basic information for weather and rain forecasts. Thermal mapping is recommended and should be extended to all of the main road sections in Finland.

B8 Development of road surface classification for controlling variable speed limits

Nesti, M; editor (1998): Report on Improved and Validated Automatic Test Sites. TROPIC deliverable D9.4. October 1998.

In the framework of the TROPIC Project, Work Package 9 had the task of analysing current automated VMS systems and to validate automatic strategies performed by test sites during trials. The subject of algorithms in use in Automated Systems has already been the object of a Deliverable (D09.2). The present deliverable is the outcome of TROPIC Task 09.4 (Propose improvements and implement in test sites) and 09.5 (Validate automatic strategies) which had the following scopes:

- to collect the experience of operating Automatic Activation of VMS
- to provide a common scheme for the evaluation of the Automatic Activation Strategy of VMS to be distributed to different TROPIC test sites
- to report the results of the validation process.

In order to fulfil the tasks, information had been collected form test sites. In order to have a coherent approach, it has been deemed necessary to provide the test sites with a common list of questions. Following the guidelines issued from previous Projects (CORD and CONVERGE), a common scheme for evaluation has been produced, named VALIDATION OF AUTOMATIC ACTIVATION.

This scheme has been circulated over the selected test sites that already have provided input in previous activities in TROPIC Workpackage 9.

The collation of the answers has made possible to write a comprehensive report related to the Automatic Activation situation and perspectives.

C1 Concept for traffic information kiosk

Liikenteen tiedotuspistekonsepti: "Uusi Tieinfo". Helsinki 1996. Tielaitos. Keskushallinto. Tielaitoksen sisäisiä julkaisuja 25/1996. [Traffic information kiosk concept "New Tie-info". Finnra internal publications] Helsinki 1996.

Keywords: road user information, information kiosks, information systems

Finnra has founded four high-quality information kiosks along with municipalities and tourist trade organizations and the Tie-info system for service stations along with the police. The operating of the old type of Tie-info system ended 30.4.1996.

In 1994, Finnra's management group accepted the road user information guidelines, which state that Finnra will form a unified network of traffic information kiosks to serve traffic information services. Finnra is also constantly under pressure from municipalities and regional tourist associations to build new information kiosks. Most parties would be prepared to also pay part of the construction and maintenance costs.

The aim of the new network of information kiosks is to provide all groups of road users with up-to-date information on road and traffic conditions, traffic safety and Finnra's operations. The network would be made up of three kinds of kiosks. Finnra would build the **high-quality "full service" kiosks** in co-operation with local tourist associations and entrepreneurs. The kiosks will be located at sites favoured by motorists along the most important main roads. The aim is to have 10-15 kiosks located every 1.5-2 hours drive away from each other. Finnra is responsible for most of the costs. Other parties can join in only under Finnra's conditions.

The network of high-quality kiosks would be complemented by a network of about 100 **information kiosks offering basic services**. Finnra would develop this network in co-operation with municipalities and local entrepreneurs. Finnra would be responsible for most of the construction costs here as well. The maintenance and utilization costs would be agreed upon separately for each project. The kiosks would be located e.g. at service stations or tourist centers an hour's drive away from each other.

During the construction, the cost of equipment for the information kiosks offering basic services has been estimated to be 50 000 - 80 000 FIM / terminal, while the cost of equipment for high-quality information kiosks are about 100 000 FIM. The costs of software maintenance and data transfer come to about 500 FIM a month / terminal.

Finnra would also offer **commercial networks** access to all of the information.

In all three types of kiosks, the basis of the service would be a **terminal** under centralized control. The Internet would be utilized in maintaining information. This would make it possible to offer people who use the Internet at home the same information.

The kiosks would look the same and follow Finnra's graphic guidelines. The selected brand name is **Tieinfo**.

Information signs indicating the locations of the kiosks would follow the principles laid down for signs indicating the locations of services. The sign would contain the **i**-symbol, which is comprehensible even to foreigners.

The communications services of central management are responsible for the **marketing of the new information kiosk concept**. The concept implementation will be designed in co-operation with the regional administration. The network can only be developed if Finnra's administration accepts the development proposals and if a sufficient number of active partners can be found. It is also important to use information services to ensure that road users will find the new service.

The project group's follow-up recommendations suggest the immediate examination of regional plans, local demand and the need to build new information kiosks. Negotiations concerning the search for possible partners and the designing of information technology should also be started immediately. The aim is to be able to alter the current kiosks, after a careful user survey, to correspond with the new concept in the winter of 96/97.

C3 Car ferry traffic information services in the Turku Region

Vägverket, Tielaitos (1997). Förstudierapport projekt Ferry. (Frankomlighets-information på färjor.

The Swedish and Finnish Road Administrations have together tried to look into possibilities to be able to inform passengers travelling by car ferries between the two countries.

The study was done partly by examining if the passengers were interested in traffic information (a little marketing research) and partly as a small scale trial on one of the Silja Line ferries (Silja Europa) between Stockholm and Turku.

As a summary, passengers on these ferries are interested in traffic information, which can promote to their safety.

The information on ferries should be carried out via some TV-media so that everyone has a possibility to access it.

Because the Swedish and Finnish Road Administrations are both investing in a more versatile ways of informing the travelers, mainly by distributing information that can be accessed via Internet, also the project suggests this solution for car ferries. Purely technically, delivering information to the ferry has been a problem. It can be problem also on other car ferry lines between the Nordic countries or on TERN- road net.

As summary, all the car ferry connections of the TERN road nework shoud have equipment for receiving this type of traffic information.

C4 E18-demo

Nurminen, Ilkka: Kelitiedotuksen multimedia-demonstraatio. Helsinki 1998. Tielaitos, Liikenteen palvelut, Tielaitoksen sisäisiä selvityksiä 27/1998, 16 pg. [Road weather information multimedia demonstration. Finnra internal publications.]

As part of the Transport telematics – E18 test area –programme, a study has been conducted on the possibilities of using the Internet to transmit information on the weather on the E18 road to road users. A multimedia demonstration was developed for this purpose. The demonstration has been in trial use on the intranet of the Finnish National Road Administration (Finnra). The aim of the demonstration is to present information in an easy and pleasant way.

The techniques behind the demonstration are outlined in this report. The demonstration programme consists of static and dynamic files. The contents of each file are introduced in this report. The dynamic data is transferred from the database with FTP and it is modified to a suitable form for use in the demonstration.

The demonstration can be viewed with browsers that support Java. It can even be used with a modem and an ordinary PC.

Some of the users have been asked about their experiences with the system. They gave some useful pieces of advice on how to make the demonstration easier to use and more attractive to road users.

In the near future, the demonstration will be placed on the Internet.

C8 PROMISE – GSM traffic information services

Tommi Ojala (16.10.1998). PROMISE - Henkilökohtainen matkustaja- ja liikennetietopalvelu. Yhteenveto englanninkielisisten raporttien tiivistelmistä. [PROMISE – Personal passenger and traffic information service.]

Mobile communication is nowadays much more than just talk. Students send one another short messages and a number of people access their e-mail on the road. The array of telematic services, also including mobile phones and cars, will increase greatly in the near future.

The PROMISE project involves the development of passenger and traffic information services that are offered via mobile communicators. These services are based on a seamless hierarchy of the producers of information, the providers of services and tele/data operators. The aim is a service that is available for a fee and covers a wide range of traffic and travel data for different modes of transport: information on alternative modes of transport, route alternatives, available services, congestion, the weather and road surface conditions.

The PROMISE project is creating the foundation for the realization of commercial information services. The PROMISE project takes three years (1996-1998) and is partly funded by the EU (the Telematics Applications programme). Nokia Mobile Phones is in charge of coordinating the project, which involves a total of 24 companies or organizations from Finland, Sweden, Great Britain, the Netherlands, France and Germany. These 24 include car manufacturers (Volvo, Renault and BMW), tele operators (British Telecom and France Telecom) and a number of producers of information, such as the national road administrations and providers of map data.

The Finnish companies and organizations involved with the project were Novo Group, Finnra, Sonera and Nokia Mobile Phones. Over a hundred Finnish test subjects have tried out the service prototype since August 1997. The actual testing ended in August 1998, but the service will be in operation at least until the end of the project. The mobile terminals used were the Nokia 9000i communicator and the Nokia 8110i-telephone. Sonera provided the trial users with GSM- and Internet connections, if necessary. The Finnish test area consisted of the area around the capital and the TERN-road E18 between Turku and Vaalimaa. Finnra provides information on traffic and road surface conditions for the system. Novo Group maintains route planning services for the whole of Finland and for the area around the capital. Novo Group is also in charge of integrating the entire system. Sonera was in charge of the services that were based on GSM short messages.

User feedback was collected with end surveys, intermediate assessment forms and group interviews. According to the information on the use of the PROMISE server, the route planning, timetable and road weather services were the most popular. 70 % of Finnish road users were quite or very pleased with the PROMISE services. An advantage in comparison with other means of obtaining information was seen to be the fact that all traffic-related information could be obtained through one service where-ever and whenever needed. Route planning services were very helpful when planning a trip, if the route and timetables were unknown. The trial users appreciated the following characteristics of the services: the accuracy of the information, the usefulness of the information and the comprehensibility of the information. The trial users were prepared to pay 20-50 FIM/month or 2-3 FIM/search for commercial information services.

The problem with the current system was considered to be the long response times of searches, caused mainly by the long time the GSM data service takes to form a connection and the occasional losses of signal. The speed of route planning services also leaves room for improvement. The services based on short messages were more popular and had lesser problems. The users wanted a wider geographical range for the services, more personal services and more developed user interfaces. Motorists wanted a route planning service that would be combined with up-to-date information on traffic efficiency, road weather, road works and accidents. The users of public transportation wanted the current trip planning services to be developed into a more door-to-door-type system. They also wanted the service to include up-to-date information e.g. on changes made to routes and timetables.

C11 Variable speed limit trial between Pyhtää and Kotka

Kauste Erkki, Pilli-Sihvola Yrjö, Portaankorva Petteri. Valtatien 7 (E18) sääohjauksen jatkaminen välillä Kotka - Pyhtää, yhteenvetoraportti. Kouvola 1998, Kaakkois-Suomen tiepiiri 3/1998, 51 pg. + 7 appendices [The extention of the weather-controlled traffic management system for E18 road between Kotka and Pyhtää.]

Keywords: speed limits, weather, traffic management, road management, road transport telematics, variable message signs, weather related traffic signs

The weather related traffic management system for highway 7 (E18) was introduced on the 11 km-long road section between Kotka and Pyhtää in December 1997. This weather- and road weather-controlled traffic management system that utilizes telematics has been realized by expanding the weather related traffic management system that has been in use on the motorway between Kotka and Hamina since 1994. The aim of the project is to increase traffic efficiency, traffic safety and driving comfort and to test and develop the applicability of the weather related traffic management system for two-lane roads.

The improvement of traffic safety will be attempted on the weather-controlled road in adverse road conditions by setting the variable speed limits to correspond to the road surface conditions and by informing motorists of the road surface conditions with combinations of variable warning and information signs. The section of weather-controlled road between Pyhtää and Kotka includes motorway, semi-motorway and two-lane road. The weather related traffic management system between Pyhtää and Kotka consists of 3 road weather stations, 31 variable speed limit signs and 8 combinations of variable warning and information signs. The project is part of the more extensive programme *Transport telematics – E18 test area*. The weather-controlled road between Pyhtää and Hamina is a total of 25 km long and it contains a total of 66 variable speed limit signs, 13 combinations of variable warning and information signs and 5 road weather stations.

The operating principles of the road section between Kotka and Pyhtää are very similar to the ones used on the road section between Kotka and Hamina. Essential renovations to the weather related traffic management system include the possibility of using a 60 km/h speed limit in extremely poor road surface conditions and in other problematic traffic situations, and the displaying of the text half of two combinations of variable warning and information signs in Finnish and in Swedish in turns.

This report describes the planning, construction and implementation of the weather related traffic management system between Pyhtää and Kotka and the experiences had during the project. The project also outlines the way the weather related traffic management system and its functioning are monitored and will possibly be developed in the future.

The construction of the weather related traffic management system between Pyhtää and Kotka cost 5.9 million FIM, and the project was implemented on schedule and according to the original budget. The basic structure and monitoring systems of the weather related traffic management system had already been realized during the construction of the weather related traffic management system between Kotka and Hamina. The annual costs of this weather related traffic management system come to about 330 000 FIM. Expanding the weather related traffic management system to include the road section between Kotka and Pyhtää increases these costs by about 120 000 FIM annually.

C12 Combinations of variable warning and information signs on the roads between Salo and Lohjanharju and between Pyhtää and Kotka

Kauste Erkki, Pilli-Sihvola Yrjö, Portaankorva Petteri. Valtatien 7 (E18) sääohjauksen jatkaminen välillä Kotka - Pyhtää, yhteenvetoraportti. Kouvola 1998, Kaakkois-Suomen tiepiiri 3/1998, 51 pg. + 7 appendices [The extension of the weather-controlled traffic management system for E18 road between Kotka and Pyhtää.]

cf. C11

C14 Operating principles of variable road surface condition message signs and the maintenance and construction principles of these systems

Kimmo Toivonen. 24.4.1997. Sääohjattu tie, Muumitalon toipumissuunnitelma. [Weather-controlled road, recovery plan for the technical building.] Kaakkois-Suomen tiepiiri 1997, 15 pg.

Keywords: data security, recovery plan, telematics

The weather-controlled road is situated in southeastern Finland, on the motorway section between Kotka and Hamina. The test area is 14 km long. The test area has a total of 36 variable speed limit signs and 5 variable information signs. Variable message signs are controlled automatically on the basis of current weather and road surface conditions. The computers and telecommunications equipment required for the system are situated in the technical building for the weather-controlled road, the Muumitalo house. This document is the recovery plan for the technical building in case of a large-scale disaster.

This recovery plan has been thus limited to the system of the weather-controlled road, the associated hardware, software and persons. The plan discusses system criticalness, basic criteria for the recovery, post-recovery tasks, the hierarchy of the tasks, the call signals for the people and organizations associated with the recovery, the recovery organisation right down to individual members, reserve routines, reserve space and reserve instruments.

The aim of the recovery plan is to make it possible to recover from an unusually big problem, which cannot be recovered from by resorting to routine means. There should be one person in charge of the recovery plan, making sure that the plan will be updated regularly. The recovery plan must be rehearsed, and the associated persons must be trained at regular intervals.

Kimmo Toivonen. 24.2.1997. Sääohjattu tie -järjestelmän tietoturvakartoitus. Kaakkois-Suomen tiepiiri 1997. 21 pg. [Weather-controlled road, data security.]

Keywords: data security, data security investigation, telematics

The weather-controlled road is situated in southeastern Finland, on the motorway section between Kotka and Hamina. The test area is 14 km long. The test area has a total of 36 variable speed limit signs and 5 variable information signs. Variable message signs are controlled automatically on the basis of current weather and road surface conditions. The computers and telecommunications equipment required for the system are situated in the technical building for the weather-controlled road, the Muumitalo house. This document is a data security investigation for the Weather-controlled road -system.

The data security investigation observes data storage systems and the information contained within these systems, classifies this information, analyses possible dangers threatening the information and selects the appropriate security measures. Data security and the security measures that are carried out are essentially the responsibility of a company's administration. Data security that is directly connected with a system is the responsibility of the persons in charge of the system.

This data security investigation has been carried out by examining data security for the Weather-controlled road –system in sections. These sections are administrative, personnel, physical, operations, hardware, software, data and telecommunications security. Essential for weather-controlled roads is the road weather data collected from road weather stations, the accuracy and availability of this data as well as variable message signs, their functioning, and the accuracy of signal control operations.

According to the investigation, data security for the weather-controlled road was relatively good. The most significant improvements were found to be the improvement of lightning protection, the addition of smoke/fire alarms at the Muumitalo house, firewalls for cable channels, the improvement of guidelines, the acquisition of reserve instruments, and the fixing of insufficient maintenance resources and deficiencies of road condition analyses and sign logs at road weather stations.

Portaankorva Petteri. Sääohjattu tie vt7 (E18) Siltakylä – Summa, Muuttuvien opasteiden ohjausperiaatteet, Pyhtää, Kotka, Vehkalahti. Kouvola 1997, Kaakkois-Suomen tiepiiri, Liikenteen hallinta ja palvelut 17 pg. + app. 5 pg. [Weather-controlled highway 7 (E18) between Siltakylä and Summa. Operating principles of variable message signs.]

Keywords: telematics, traffic control, traffic information, speed limits, weather controlled road, variable message signs, road conditions -controlled speed limit, weather

The weather-controlled road section on highway 7, part of the TERN-road E18, between Siltakylä at Pyhtää and Summa at Vehkalahti belongs to an area which experiences rapidly changing weather due to the vicinity of the sea. This weather-controlled road that belongs to the transport telematics' test area is 25 km long and serves as an example of the efficient traffic management system developed by Finnra.

There are attempts to improve traffic efficiency, traffic safety and driving comfort on the weather-controlled road by setting the variable speed limits to correspond with the road surface conditions and by informing road users of the road surface conditions with combinations of variable warning and information signs.

The operating principles describe the location, extent and operating principles of the weather-controlled road and the objectives of the weather-controlled road and the transport telematics test area. The operating principles also discuss the collection of weather and road weather data, the operations of the road weather system on the weather-controlled road and the restrictions, warnings and messages that will be displayed on variable message signs on the weather-controlled road.

The operating principles outline the operating principles of variable speed limits and combinations of variable warning and information signs on the weather-controlled road and the conditions that can affect the the automatic control of variable message signs. The operating principles also outline the principles for the utilization of manual control, operating guidelines for data documentation and guidelines concerning announcements during technical difficulties.

Road users are informed of changes in the weather and road surface conditions in real time on the weather-controlled road with variable speed limit signs and combinations of variable warning and information signs. The weather-controlled road has 5 road weather stations, 66 variable speed limit signs and 13 combinations of variable warning and information signs.

The variable message signs on the road section are usually controlled automatically according to the weather and road surface condition. The individual variable speed limit signs are connected to operational signal groups. In the road weather system, the automatic control system divides the information collected from road weather stations into road surface categories. The signal groups have been defined speed limits in four different road surface categories. The combinations of variable warning and information signs display warnings automatically on the basis of information obtained from road weather stations. The road section can also be controlled manually to ensure traffic safety, traffic efficiency and driving comfort.

D1 Effects of the weather-controlled traffic management system in the motorway section between Kotka and Hamina

Pirkko Rämä: Sää- ja kelitietoon perustuvan liikenteen ohjausjärjestelmän vaikutukset Kotka - Hamina -moottoritiellä. [Effects of the weather-controlled traffic management system in the motorway section between Kotka and Hamina.] Helsinki 1996. Finnra,Tielaitoksen selvityksiä 1/1997. 64 pg. + app. 23 pg. ISBN 951-726-311-2. ISSN 0788-3722. TIEL 320 0488.

Keywords: traffic control, legal systems, variable message signs, speed limits, road conditions, drivers, behavior, influences

This study was designed to investigate the effects of weather-controlled speed limits and displays on driver behavior. Specifically, we collected data on (a) vehicle speeds and headways and (b) driver acceptance. In addition, system performance and reliability were evaluated.

The system consisted of thirty-six variable speed limit signs and five variable warning and information signs that were installed along the 14 km-long motorway section between two Finnish cities (Kotka and Hamina) on Finland's southern coast. Local weather and road surface conditions were monitored automatically from road weather stations, and the information was used for determining appropriate speed limits and for controlling variable warning and information signs. The maximum speed limit was 120 km/h in the summertime and 100 km/h in the wintertime. If the road was slippery (because of snow, ice or water), the speed limits were 100 or 80 km/h.

Speed and headway data were obtained from detector loops. In addition to this, speed profiles along the section were studied by following certain vehicles with instrumented cars. The road weather data and status of variable signs were recorded at the control center. The road surface judgements based on the road weather station data were compared with manual observations of the road surface conditions and friction measurements. Finally, road users were interviewed in four road-side surveys.

In the wintertime the change from 100 km/h to 80 km/h decreased the mean speed of cars travelling in free-flow traffic by 3.4 km/h, in addition to the average mean speed reduction of 6.3 km/h caused by the adverse road surface conditions. The corresponding effect was 2.5 km/h for all cars in addition to the effect of the adverse weather conditions (-6.3 km/h). If there was no rain or if the effects of the rain were insignificant, the effect on total traffic was a speed reduction of 4.6 km/h, containing an increased reduction of 2 km/h. The proportion of these conditions was approximately 95% of all adverse road conditions. When the road condition was such that the 'slippery road' warning was displayed, the speed reduction was 1.8 km/h for cars travelling in free-flow traffic (the effect of the weather was –9.3 km/h in this situation). In addition, the reduction of speed limits on the experimental road decreased the standard deviation of the speed.

In the summertime, the lowering of speed limits was mostly caused by the risk of hydroplaning. The change from 120 km/h to 100 km/h decreased the mean speed of cars travelling in free-flow traffic by 5.2 km/h, and the change from 120 km/h to 80 km/h by 8 km/h in addition to the average decrease in the mean speed caused by adverse road surface or weather conditions (-2 km/h and –6.1 km/h).

The results of the survey showed that 88-94% of the interviewed drivers (n=590) recalled the variable speed limit signs. However, only 66% of the interviewed drivers (n=61) recalled the variable slippery road sign. Furthermore, 81% of the drivers expressed the view that the displayed speed limit was appropriate, and 95% of the drivers expressed the view that the variable speed limits were useful.

During the winter of 1995-1996, the decreased speed limit (80 km/h) was applied for 21% of the time. In the summertime, the decreased speed limit of 80 km/h was applied for 3% of the time, while 100 km/h was applied for 20% of the time. Comparisons of the displayed speed limits and manual observations of the weather and road conditions indicated that the speed limits were too high in 26% of the cases. The speed limits displayed were seldom too low.

It is concluded that the system of weather-controlled speed limits and displays improved traffic safety by decreasing mean speeds and the standard deviation of speeds. However, this first system of this kind was assessed not to be socioeconomically profitable. Drivers accepted the lowering of the speed limits because of poor weather and road conditions. Evaluations of system performance showed that the methods used to detect slipperiness need further development.

D2 Impact study of trial of enhanced weather monitoring system

Mikko Malmivuo, Kirsi Pajunen: Tehostetun kelinseurantajärjestelmän kokeilu - Tieliikenteen telematiikan E18-kokeilualua. [The experiment of enhanced weather monitoring system – Road transport telematics experimental area on the E18.] Helsinki 1998. Finnra,Tielaitoksen selvityksiä XX/1998. 65 pg. + app. XX pg. ISBN 951-726-XXX-X. ISSN 0788-3722. TIEL XXX XXXX.

The aim of this study was to examine how the activities in Road Weather Monitoring- and Road Traffic Information Centers changed after the implementation of the enhanced weather monitoring system. The analysis concentrated on four sectors: the effects of the enhanced system on road maintenance duty personnel and traffic control, friction measurements in the test area and the automatic control of variable speed and information signs.

According to interviews, the attitudes of Road Weather Monitoring center duty personnel have changed sometime between the last two winters, the attitudes during the latter winter (1998) being much more positive. Surveillance of the activities of Road Weather Monitoring Center duty personnel indicated that the duty personnel paid only limited attention to the road weather station data, especially in those circumstances when the area of snowfall moved closer. The duty personnel would have watched the weather cameras more, but malfunctions and the slow updating of the camera images limited their use.

The Traffic Management Center duty personnel looking after the automatic control of variable signs had to intervene in the signal control almost every day. Occasionally, the duty personnel tried to "level out" the speed limit recommendations of different speed limit areas in order to have the same speed limit in adjacent areas. This kind of action deviates from the principles of enhanced weather monitoring, as the original idea was to take local circumstances into account when changing speed limits.

There were no major variations in the friction levels between different weather stations in measurements carried out in the test area.

Taking into account the existing technical level of road weather stations, the enhanced network of road weather stations has not been particularly beneficial for Road Weather Monitoring Center duty personnel, but the network was useful for the automatic control of variable signs. Especially whenever a rain area moved closer, the use of multiple rain and road condition sensors seemed to increase the reliability of road condition assessments. On the other hand, the study was not able to prove whether the reliability was increasing due to the greater number of road weather stations or solely due to the increased number of sensors.

If the technical level of road weather stations improves clearly, it is assumed that, especially in those circumstances when roads are going to be icy, duty personnel will use the enhanced network much more than nowadays.

D5 The socio-economic profitability of the Kotka-Hamina weather-controlled road

Lähesmaa Jukka. Kotka - Hamina sääohjatun tien yhteiskuntataloudellisuus. [The socio-economic profitability of the Kotka-Hamina weather-controlled road.] Helsinki 1997. Tielaitoksen selvityksiä 36/1997. TIEL 3200482, ISBN 951-726-368-6, ISSN 0788-3722. 45 pages + 5 appendices

Key words: investment calculation, cost-benefit analysis, traffic management, road weather information system, speed limit, variable message sign

The purpose of the study was to find out the socio-economic profitability of the Kotka-Hamina weather-controlled road. The study also illustrated how changes in the cost components affect profitability. Based on this, estimates were made about how similar road weather information systems could be made more profitable in the future.

The socio-economic costs of traffic were estimated on the basis of the changes the road weather information system causes in average speeds and the number of accidents. Variable speed limits that are controlled according to weather and road conditions decrease speeds during adverse road conditions, when the accident risk is many times higher than during normal conditions. This makes it possible to save in accident costs without a significant increase in time costs. The accident costs of the Kotka-Hamina weather-controlled road were estimated to decrease by about 1.1 million FIM annually, while the time costs are increased by less than 500 000 FIM. The weather control system has only small effects on the other evaluated socio-economic cost components.

The productivity and profitability of the system were calculated by comparing the total socio-economic impacts with the investment and maintenance costs. The construction of the weather control system cost some 8.2 million FIM, while the annual maintenance costs come to 330 000 FIM. The benefit-cost ratio of the investment is 0.5, and the remunerative rate of interest is 4 per cent. The socio-economic savings account for only half of the total costs of the system, and the return on investment is poor.

The Kotka-Hamina weather-controlled road is an experiment, and its costs were not the main concern during its construction. If a similar system would be built now it would cost 2.2 million FIM less. In addition to this, by using the system on a longer road section, where the fixed construction and maintenance costs would have a relatively smaller share, and by trying wireless communication, it would be possible to reduce the costs even more. If these preconditions can be met, weather-controlled roads can be a socio-economically profitable investment.

D6 The impacts of variable road surface condition message signs on driver behavior

Juha Luoma, Pirkko Rämä, Merja Penttinen ja Virpi Harjula: Muuttuvien keliopasteiden vaikutukset kuljettajan toimintaan. [The impacts of variable road surface condition message signs on driver behaviour.] Helsinki 1997. Finnra, Tielaitoksen selvityksiä XX/1998. 61 pg. + app. 8 pg. ISBN 951-726-350-3. ISSN 0788-3722. TIEL 320 0469.

A recent Finnish study conducted by Rämä, Kulmala and Heinonen (1996) showed that the variable sign warning about slippery road conditions reduced the mean speed by 1-2 km/h and that the variable sign recommending the minimum headway between vehicles decreased the proportion of the drivers following other vehicles with a headway of less than 1.5 seconds by 28-38%. However, the signs might have other impacts on driver behavior in addition to the effects on speed and headway. Consequently, this study was designed to investigate other potential responses to these signs.

The data were collected via telephone interviews involving willingly participating car drivers. The earlier roadside interviews sampled drivers who encountered either of the signs during adverse road surface conditions. Specifically, each roadside interview was conducted while the measured friction coefficient was between 0.2 and 0.3. In all, 114 drivers who had encountered the 'slippery road' sign and 111 drivers who had encountered the minimum headway sign were interviewed. The questions concerning the slippery road sign discussed the prevalent road conditions (snowfall) and slippery road conditions that are not easily detectable ('black ice'). The questions concerning the minimum headway sign only involved the prevailing 'black ice' conditions.

In both road conditions, the interviewed drivers indicated that the slippery road sign influenced particularly the driving speed and focusing of attention. Drivers reduced their driving speed in general and particularly in curves, concentrated on their own driving more than usual, were attentive, and monitored opposing traffic more than usual. In the 'black ice' conditions, there were, on average, more reported responses than in the prevailing road conditions. In addition, the testing of road slipperiness by braking increased in these road conditions.

Furthermore, the drivers relatively frequently reported the following responses: improved driving comfort, extended headway, refraining from passings, and different use of controls (steering, brake pedal, or gas pedal). The effects on the driving speed and headway correlated positively with many other responses.

The drivers indicated that the minimum headway sign especially influenced the following distance (by increasing the distance or distance monitoring). In addition, the following effects were indicated relatively frequently: monitoring the vehicle ahead, focusing on one's own driving, discussing the meaning of the message, checking and generally reducing the driving speed, and testing road slipperiness by braking.

The results suggest that these variable message signs have many other impacts than can be measured in terms of speed and headway. The most essential effects deal with the focusing of attention to find clues indicating potential hazards, the testing of road slipperiness, and careful passing behavior. On the other hand, the results suggest that driving speed and headway are also the most essential variables, which many other variables correlate with.

D8 Effects of variable speed limit sign of fiber-optic technology on information overload

A recent study showed that the variable speed limit sign using fiber-optic technology is more effective than the electromechanical sign. More specifically, the fiber-optic sign decreased the mean speed more than the electromechanical sign and the drivers more frequently recalled the sign when the fiber-optic sign was used. However, it was concluded that more research is needed to evaluate whether a sign with a high attention value diverts the driver's attention from adjacent fixed signing. Consequently, this field study investigated the effects of the speed limit sign of fiber-optic technology on recall of a fixed warning sign located in the vicinity, while the effects of the fixed speed limit sign were used as controls. In addition, effects of signing on speed behavior were examined to follow up the effectiveness of the fiber-optic sign. The results showed that drivers were less likely to recall the warning sign when it was in the vicinity of the fiber-optic speed limit sign than in the vicinity of the fixed speed limit sign. Specifically, 8.3% of the drivers who had passed the fixed speed limit sign recalled the warning sign, but only 4.2% of the drivers recalled the warning sign when the fiber-optic variable speed limit sign was used. The speed results showed that the magnitude of the speed effect of the fiber-optic sign was somewhat smaller than one year earlier.

D9 Development of the comprehensibility of RDS-TMC messages

Juha Luoma, Virpi Harjula, Merja Penttinen: RDS-TMC-viestien ymmärrettävyyden kehittäminen. [Development of comprehension of RDS-TMC messages.] Helsinki 1996. Tielaitos, Tielaitoksen sisäisiä julkaisuja 20/1998. 24 pg. TIEL 4000184.

This study investigated the comprehensibility of messages selected to be used in the RDS-TMC service. Sixty licensed drivers were interviewed. The drivers varied in age from 18 to 65. The interview consisted of three parts. The first part was a comprehension test, followed by a preference test. The last part of the interview concerned the question of how long drivers expect to wait when they hear about a traffic event that may cause delays in traffic.

The results showed that most drivers understood the following phrases correctly in both four-lane motorway and two-lane road environments: *lane closed*, *only one lane in use* and *carriageway reduced* (from two lanes) *to one lane*. There were no major problems in understanding the phrases *single alternate line traffic* (two-lane road) and *slip road* (four-lane motorway).

The phrases *two lanes closed*, *carriageway closed* and *contraflow* – in the context of the four-lane motorway – were not clear; every third driver misinterpreted them.

The phrase *people on roadway* was understood better than *pedestrians on roadway* as indicating events involving unexpected pedestrians on the road.

The phrase *expected* was understood as more certain than *danger of* or *possible*. In addition, there were indications that the phrase *expected* was preferred if the uncertainty was about the nature of the event (e.g. the amount of traffic), while the phrase *danger of* was preferred if the uncertainty was about the time of the event (e.g. the length of delay).

Traffic and traveler information often consists of information on a cause and an effect. These two parts of the message can be provided in two orders (i.e. the cause followed by the effect or the effect followed by the cause). The interviewed drivers preferred the first option, with the cause followed by the effect (e.g. *lane closed. queuing traffic*). The effect segment that stated *directing traffic* was judged by drivers to be the most essential one.

In the last part of the study the drivers estimated the duration of a regular delay and a long delay in connection with four different events. In the case of accidents, the mean estimate of the delay was 17 minutes. A 48-minute delay was considered long. The estimated delays in case of road repaving works, sports events, and hoisting bridges were 9-12 minutes; 24-29 minutes were considered a long delay in those cases. Drivers clearly anticipated longer delays as a result of accidents. However, there was a wide range of estimates of delays by different drivers.

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